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NATO: A BUSINESS HISTORY

Volume III of three

by Robert R. Foxcurran

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CHAPTER 10

MODE #5 - TRANSATLANTIC JOINT DEVELOPMENT

This Mode of industrial collaboration is one that has encountered greater difficulty than any other Mode. Here we cover three failures; the MBT-70, AVS fighter, Mallard-tactical communication system; one partial abort, the NATO PHM; and two successes, the NATO Seasparrow and the CFM-56. These latter two projects suggests some guidelines as to where and how this Mode can work, and is also highly important for Mode #8 of industrial collaboration (the Family of Weapons concept).

This Mode has faced serious problems in several areas. Chief among these are:

(1) The greater difficulty of coordinating the input of the users, and maintaining their support for a given requirement, especially on the U.S end.

(2) Balancing the overwhelming proportionate U.S. governmental and industrial share of such programs, with the preference of the larger European nations for collaboration on an equity basis.

(3) Establishing a politically acceptable yet effective chain of command within both the industry and government teams.

(4) U.S. export restrictions.

A. TWO SPECIFIC AREAS WHERE U.S. PARTICIPATION IN JOINT DEVELOPMENT HAS WORKED

Before going into the six projects, two related areas are treated briefly: lower level transatlantic cooperation in R & D and the U.S.-Canadian relationship.

1. Lower-level Transatlantic Cooperative R & D Projects

In contrast to the examples of transatlantic co-development of major systems there are a plethora of recent examples of lower-level transatlantic cooperative R & D projects, amongst which there has been a higher rate of positive results. Amongst these are two principal categories. First, there are those covering a broad range of basic research and exploratory development which are too numerous to enumerate. Second, there are a small number of subsystems which have successfully completed engineering development. Implementation is either through the work being divided up between participants with each participating country funding its respective effort or by having the two or more participating nations collectively fund the work which is carried out unilaterally in one nation.

a. Basic Research and Exploratory Development

An example of the U.S. cooperating in exploratory development was the U.S. Army-UK program on fuel cells. A fuel cell generates direct electrical current through the cold chemical reaction between oxygen and hydrogen. The objective of the work was to form a basis for developing efficient, advanced,

low-cost electrical power sources. The project took place between 1968 and 1974 costing a bit over one million dollars and was one from which both parties benefited economically as well as technologically.[1]

The U.S. Navy set up a shallow-water acoustic basic research program in June, 1972, with the FRG and Netherlands. The program is concerned with gathering basic hydroacoustic data, exploring environmental acoustics of the Baltic Sea, and testing sound propagation in selected areas of the western Baltic Sea. The program's objective is to expand the shallow-water research data bank of the participants by capitalizing on each others research.[2]

Another cooperative basic research project involved the U.S. Army and the FRG in studying the effects of transient radiation effects on electronics as relating to the Leopard tank. The work was carried out between 1971 and 1975 solely in the U.S.[3]

There are also a number of NATO associated coordinating group activities and technical centers, that contribute to technical information exchange and the initiation of cooperative efforts. These include, in addition to CNAD and its Service Armaments Groups and the Defense Research Group, the NATO Science Committee, and the Advisory Group for Aerospace Research and Development (AGARD). These are examples of NATO coordinating bodies which continuously provide a

working mechanism for cooperation. The SHAPE Technical Center (STC) and the SACLANT ASW Research Center, are both jointly funded and staffed research activities, that support NATO military organizations in scientific and

technical matters.[4] Then there is the Azores fixed acoustics range facility, which is almost NATO-wide, being commonly funded by the U.S., UK, FRG, Netherlands, France, Italy, Canada and Portugal.[5]

b. Engineering Development

Most of the cooperatively developed subsystems involving the U.S. that have successfully completed engineering development have involved Canada as the other partner. Here, however, we are concerned with the U.S.-European relationship not the unique U.S.-Canadian one, which will be briefly treated, shortly.

Even though there has been historically a fairly high attrition rate among the transatlantic co-development programs there have been several that have completed engineering development.[6] One of these is the U.S.A.F. and the FRG cooperative (advanced and engineering) development of a side-looking airborne radar system. The initial program took place between 1968 and 1974 and cost some $24 million. The radar provides all-weather reconnaisance in three-dimensional picture-like presentation with greater aerial coverage.[7]

c. Two Funding Methods

The first of the two arrangements for funding and distributing work was used in the case of the U.S. - UK cooperation in fuel cells development and the U.S. -FRG -Netherlands shallow-water acoustic research program. For the fuel cells program the work was divided up between the U.S. and UK, with each

funding its own effort. The U.S. share of the costs came to 63% of the total. The shallow-water acoustic research program followed a similar arrangement.

In the case of both the side-looking airborne radar and the transient radiation effects on Leopard tank electronics programs all work was performed in the U.S. For the former program the cost was shared 50 - 50 since both nations had a requirement, but with the latter program the FRG provided for the total funding.

In both cases the FRG was basically just buying technology. This arrangement though does not necessarily depend on lack of capability on the part of one partner to perform its share of the work as is exemplified in the development of the Javelot forward air defense missile system project. The U.S. agreed to pay 50% of the development cost while all development work was in France. The project began in April 1971 with an estimated completion date of April, 1976, and amounted to several million dollars.[8]

2. The U.S. - Canadian Production Sharing Agreement (1963)

A special relationship exists between the U.S. and Canada that is unique among NATO relationships and provides for close cooperation in military research and development, as well as production. In 1963, the United States - Canadian Development Sharing Program was established as a natural followup to the U.S. -Canada Production Sharing Agreement of 1941, and the 1950 Joint Statement of Economic Cooperation.[9] More immediately, this Development-Sharing Program stems from a 1958 decision of the Canadian Government that it was no longer

practical to undertake unilateral development of major military systems for the meeting of Canadian military requirements. Since this meant that subsequent procurement of major military systems would be from off-shore sources, primarily the U.S., it was necessary to establish a framework that would allow for the maintenance of Canadian industrial and technical capability which could provide for offsetting sales. This led to the expansion of the U.S.-Canada production sharing to include development sharing as well.

Under the Development Sharing Program the U.S. pays for at least 25% of the cost of individual Canadian projects, but for the most part, cost sharing comes to around a 50 - 50 split. All work on these projects is done in Canada.

The stated objectives of the program are:

(1) To assist in maintaining the Defense Production Sharing Program at a high level by making it possible for Canadian firms to perform research and development work undertaken to meet the requirements of the U.S. Armed Forces.

(2) To better utilize the industrial, scientific and technical resources of the United States and Canada in the interest of mutual defense.

(3) To make possible the standardization and interchangeability of a larger amount of the equipment necessary for the defense of the United States and Canada.

1 Comptroller General of the United States, Benefits and Drawbacks of U.S. Participation in Military Cooperative Research and Development Programs with Allied Countries, 1974, pp. 11 and 37.

2 Ibid., p. 13

3 Ibid., p. 37

4 Ibid., p. 39

5 The Azores facility is for conducting fixed underwater voice communications experiments.

The Navy wanted to develop data for such a communication system, using the most adverse conditions as a basis and thereby establishing the parameter within the system would have to operate. The Azores area had the environmental and geographical conditions most desired. As a result, the Navy has gained access to an area that the United States might otherwise have had to rent, or worse, have been denied access to.

6 Several such projects involving U.S. Mutual Weapons Development Program (MWDP) funding are mentioned elsewhere in the paper.

7 Comptroller General, op. cit., pp 10-11

8 Ibid., p. 19.

9 The 1950 Joint Statement of Economic Cooperation was closely related to the Canadian decision of the same year to surplus its older WWII British equipment and to re-equip its land forces with American equipment (covered in Chapter 5)

B. The U.S.-FRG MAIN BATTLE TANK FOR THE 1970's (MBT - 70)

In October 1960, one of the NATO working groups emanating from the U.S. joint development initiatives, called the Twenty Projects, was convened on battle tanks. The U.S. government felt strongly at the time that transatlantic joint design and development projects were a natural and necessary expansion on the recently launched joint production programs. As we will shortly see however, where joint development was to be successful during the 1960's would be almost exclusively on an intra-European basis, not a transatlantic one. This was for a number of reasons; including: a shift in U.S. priorities because of the gold flow crisis and war in S.E.A.; and the need for Europe's 3 medium powers to collaborate in projects as coequals.

It quickly became clear to the NATO working group that any joint tank development effort would have to be oriented towards a production horizon of no sooner than ten years, since all of the other three major NATO countries—France, the FRG, and the UK—were all in the midst of their own tank development programs. The French and German projects were still in principle one joint project launched back in 1957, but one destined to result in the German Leopard I and the French AMX-30 (see Chapter 8).

Nevertheless, these talks eventually bore fruit in April 1962 in the form of a joint components agreement between the U.S. and the FRG, within the framework on the U.S. side of the Mutual Weapons Development Program (MWDP). Through the program, the components were aimed at providing a tank whose mutually agreed-on characteristics were close to those of an as yet unbudgeted U.S.

successor to the M-60. Costs were to be shared and the program was to be administered by 2 national representatives meeting regularly as a Program Management Board.

Independently of the US-FRG joint development agreement reached at the level of the two army staffs, at the ministerial level a joint tank development project came to be seen as desirable to both parties. Secretary McNamara had pressed German Defense Minister Strauss in April 1961 on the subject of joint developments and particularly on the tank, whose development the U.S. badly needed. The Army had previously approved in 1959, a plan for development of a main battle tank to be available by 1964, but it had remained unbudgeted. In July at a NATO Defense Ministers meeting Strauss proposed, instead of a joint development project, that the U.S. adopt the forthcoming Leopard tank which would be available in 1965. As one might expect, this led nowhere. In any event, with the twin goals of strengthening NATO bonds and sharing the burdens of weapons development, McNamara maintained the pressure on the NATO allies for joint programs, and especially the most amenable (i.e. vulnerable) of them, the FRG. The official line of thought was shown in a memorandum to McNamara from the Deputy Secretary of Defense, Research and Engineering in early 1962. It stated that "any funding (for a new MBT) after 1963 should be contingent on equal participation and support by two or more allies."[1]

1. The Intergovernmental Organization

On instructions from the two Ministries of Defense, negotiations began in Bonn in June 1962 with the U.S. proposing the MWDP agreement on components as a

basis for the complete tank development. The following year, on August 1, 1963, U.S.

Secretary of Defense McNamara and German Defense Minister Kai-U ·on Hassel signed an MOU in which th U.S. and the FRG agreed to jointly develop a new main battle tank on a 50-50 basis. Key objectives therein were to design a type of tank embodying improved military characteristics that would be agreed upon by the two governments and to be ready for production by not later than 1970. The MOU also outlined additional objectives including the construction of eight prototypes in each country (or all 16 in one country if so agreed). Thus, after almost three years of concerted efforts (dating from the initiation of the Twenty Projects) began the U.S. Armed Forces' first major joint development venture, for a system to be introduced into its own inventory.[2]

On the heels of the MBT-70, the following year, another major US-FRG project, the AVS (V/STOL, fighter) was launched, as well as several purely European projects. It began to appear that both transatlantic and intra-European joint development efforts were picking up momentum. As we'll see though, most of the European projects survived while the first two transatlantic projects and the several that followed them, were to suffer a devastatingly high attrition ratio.[3]

For starters, both the MBT-70 and the AVS projects were created in an era of financial plenty by the two nations defense ministers. In addition, all of the key personalities on the U.S. side who figured prominently in its birth were civilians. Besides the Secretary of Defense, this included the Deputy

Secretary of Defense and the Secretary of the Army. In his 1975 study Richard Trainor brought out that + U.S. Army initially regarded the MBT-70 as not there own project, but more as a "gift from afar," and "did not appear to feel that they had total management responsibility for, or control of, the program until years later."[4]

Within a few days of the signing of the MOU each nation had appointed its Program Manager. The U.S. Program Manager was Brig. (later Maj.) Gen. W. G. Dolvin and the German Program Manager was Dr.-Ing. Fritz Englemann, a career civil servant and engineer. Both received the highest-level backing from their respective governments and immediately set out to gather their respective staffs.

On October 9, 1963, the Program Management Board, exercising overall control of the program and retaining full responsibility and authority over all aspects of the program, held its first meeting in Bonn in an atmosphere described as one of "absolute parity." The two program managers planned to meet every two months and created a number of working groups. Principal among these were legal and finance, concepts, specifications and standards, and military requirements. An embryonic Joint Design Agency was also organized, but staffing it was put off pending the outcome of the on-going discussions.[5]

A major U.S. proposal at this first meeting was to undertake an operations research study in which leading potential design concepts from both countries would undergo computer simulated tactical wargaming that would assist the

nations in concept selection. Known as the Parametric Design/Cost Effectiveness Study (PD/CE), this proposal quickly found favor with Dr. Engelmann. Since no German firms were experienced in this area, it was agreed that a U.S. contractor would be selected.[6]

In order to insure the objectivity of the contractor selected for the one-year study contract, one that would provide input into design selection the contractor was to be barred from the actual development. Unfortunately though, as it turned out the firm selected in February 1964, Lockheed, had never designed or produced a tank or similar vehicle. Originally this was evidently not viewed as a serious drawback, but an advantage in that it didn't thin the ranks of the already limited number of potential U.S. competitors.

Based on a cost per pound using much less sophisticated tanks and estimating that a high performance tank could be built within a weight of 35 short tons, early cost estimates turned out to be well short of the mark.[7]

As the PMB continued to organize its work during the early meetings the 'absolute parity' developed into what became widely known as the 'einz fuer eniz' (sic) principle: one for one. That is, for every American, a German or vice versa at

every level. This was the common approach of the period, seen as well in several other concurrent joint development projects, such as the Concorde and the Jaguar. The U.S. Program Manager saw this as beneficial because it required close collaboration and communication between Germans and Americans

across the board, up and down. In addition, the German Program Manager, Engelmann, favorably compared this "togetherness" with the Franco-German experiences in their joint program that finally collapsed in 1963 and resulted in the Leopard I and AMX-30 tanks. "German engineers remained in Germany, French engineers remained in France...The result...: two tanks, a German tank and a French tank."[8]

Whether or not 'einz fuer einz' was the proper solution to the joint management problem, the phrase was destined to reverberate throughout all levels of the organization, becoming the 'Leitidee,' or central concept.[9]

Early in the program an impasse was reached over whether to use metric of Anglo-Saxon units in designing the tank. One of the working groups established by the PMB was charged with the problem. Each side and in particular each industry marshalled all sorts of arguments. Under pressure from the various industry associations and bureaucracies, neither the working group nor the PMB could reach a decision. Richard Trainor explained this inability to resolve the issue as having been caused by a feeling that the program was to establish a precedent for other major bilateral joint development programs. Both sides feared potential collateral damage to unspecified future programs, which tended to create rigidity in early negotiations at a time when flexibility and trust were especially required. In accordance with the MOU the dispute was referred to the ministerial level.[10]

The German Minister of Defense was also looking at the decision as a precedent, despite McNamara's desire to limit the problem to the MBT program. In

May 1965 McNamara and von Hassel agreed that the Anglo-Saxon system would be used for U.S. developed components and metric for those developed in the FRG, but metric fasteners would be used at the interface between Anglo-Saxon and metric components. These negotiations were time consuming and delayed the beginning of detail design.[11]

By the time of the second PMB meeting in December, it had become evident that a full-time joint government engineering agency was essential. Working groups meeting periodically could not provide the necessary day-to-day direction to Lockheed, to the component developers, or give appropriate and timely guidance to the key industrial participants after the contracts were awarded. As pointed out by Hochmuth in his study "Organizing the Transnational."

> In the German contractual system, where the contractor had a relatively free hand and "led" the government, such a f ll-time agency might not have been absolutely essential. But U.S. tank development procedures were based on close supervision and could not function without a supervising agency.[12]

This agency, called the Joint Engineering Agency (JEA) was set up Augsburg, FRG, in September 1964. Its assigned mission was to provide technical direction, control, and supervision of the program. Though Dolvin had intended to solve the issue of location by exchanging leadership for location, by force of personalities, the head of the German team became acting chief of the JEA, as well.[13]

2. Selection of the Industrial Team

In the matching up of government agencies and industrial partners, the MBT-70 program exemplifies a dilemna faced in many other transnational projects, as well. The following quote from Hochmuth's Organizing the Transnational captures this:

> On the U S. side, the development of tanks had historically been the responsibility of the Ordnance Corps, which had a long tradition of "inhouse" capability based on the Army-run industrial arsenal system. This meant that there existed a reasonably competent and experienced staff of engineers and production technicians who would give detailed guidance and supervision to Ordnance contractors. The German tradition was to rely almost wholly on industry for leadership in development and production. Consequently Dolvin's staff envisioned an "Engineering Assistance Contractor" who would work hand in hand with a well-established group of government engineers. The Germans, on the other hand, had sought a financially and technically competent firm with the management ability to run the development.[14]

But here the German Program Manager faced a problem. The FRG's reborn tank know-how was concentrated at Krauss-Maffei a major heavy machinery firm located in Munich and controlled by the Flick group that had developed the Leopard.

The German government, being unwilling to rely solely on Krauss-Maffei as a production source sought to use the MBT-70 to broaden its industrial base. Again quoting from Hochmuth:

> Here two characteristics of the German system came into play. First, in Germany the engineering team that develops a product generally stays on during production. This meant that any new contractors would have to create a new engineering team, and there was a scarcity of good engineers. Second, a German development contractor who worked on a cost-reimburseable basis for the government was limited to a very small profit—3 percent to 5 percent compared to about 10 percent for U.S. contractors. His real profit came from production royalties only if and when the government procured the product in quantity.....
>
> A related and even more crucial difference was that under German law the engineer who designed a product or a component also had a proprietary interest in the production royalties and stood to gain a sizeable sum if his design was produced. This could have meant as much as a $60,000 bonus to a German designer in the MBT program.[15]

Consequently the German government was worried that it couldn't build a strong enough industrial partner to work with U.S. industry on equal terms.

It was against this backdrop that the German Program Manager approached Harold Quandt. Quandt did not find the building of a consortium to be an easy task. However, by early 1964 he had lined up seven firms, among them Porsche, Daimler-Benz, Krauss-Maffei, and Rheinstahl most of which had been previously involved in the development of components and were likely candidates for inclusion in the MBT program. The Deutsche Entwicklungsgesellschaft (DEG) was incorporated in July, 1964.[16]

In the U.S. the program management office requested bids from U.S. companies in March, 1964 and General Motors was selected over Chrysler and Ford Machinery—Aeroneutronics. One of the considerations working in GM's favor, at least vis-a-vis Chrysler, was its multinational character. It was felt that its OPEL interests in the FRG would give them negotiating leverage with any prospective German partners. On this point however, Hochmuth was doubtful as

to whether these officials were aware of a long-held GM policy against entering joint ventures within the U.S. or abroad.

In bidding, GM had allowed for a considerable systems management effort. But since their bid substantially exceeded the funds available and planned, the systems-management portion was deleted placing GM in the role of an assistant. Managerial responsibility remained with the government engineers on the U.S. program manager's staff.

GM's initial task under the contract was to perform a 6-month study effort, together with the selected German contractor, preparing a plan for active development. Immediately after the signing of the contract GM engineers were off to the FRG to start discussions with their newly formed counterpart, DEG, and German government officials.

But DEG did not yet have a contract. Principally due to the employees' proprietary rights issue, it was not to get one until November. The German government had agreed to furnish these royalty-free to the U.S. government, but the problems arising from the German remuneration system were not easily overcome. There was very hard bargaining. This dilemma was at the root of a damaging incident later in September.

3. The Inter-governmental JEA and the Inter-industrial JDT Are Set Up in Augsburg

After discussion at length over how to organize the joint industrial effort at

the March 1964 meeting of the PMB, it was decided that it would be better if the firms selected worked it out for themselves. It had been agreed however, that whatever concept was selected, the JEA and the joint industry team should be collocated.

So it remained for the two contractors to decide on the industrial structure. Hochmuth described the efforts expended towards this end as follows:

> In July 1964 Quandt had made a proposal to the FRG which called for a jointly staffed full-time engineering group supervised by a bilateral board of directors from the two prime national companies. But DEG and GM were a long way from a meeting of minds. Therefore, as soon as agreement was reached on the JEA, the program managers drafted instructions to the two contractors directing them to set up an interim Joint Design Team (JDT) to be collocated with the JEA. Presumably this could be altered when the industries reached agreement. In an effort to reach such an agreement representatives of GM and DEG had a month-long meeting in Essen, beginning August 14. This meeting then moved to Detroit. The DEG negotiators, led by Quandt resisted GM and U.S. efforts to create a large JDT. Later they countered with proposals which would have reduced the role and importance of the JEA, a situation more akin to normal German practice. GM's contract with the United States did not give them total system responsibility,and since GM was still actively seeking additional defense work, they would not agree to any moves which might endanger their relations with the Army. Whatever the factors, little came of the meeting. There was no powerful joint agency, not even a "lead" contractor. The two companies simply agreed to staff the JDT jointly and established basic work procedures.[17]

In September, 1964 the team of government engineers lead by a Gene Trapp and another team of 15 GM engineers headed by Clarence Crockett arrived in Augsburg, as the U.S. halves of the interim governmental JEA and the interim industrial JDT. Trapp and his German counterpart Hellwig felt that the JEA, with the assistance of the JDT would need some six months to work up a concept

and do enough engineering to enable them to return home and carry out the work.

Hellwig and Trapp reportedly got along well together, and in part because Hellwig was clearly senior, he became acting chief of the interim JEA. The 'einz fuer einz' philosophy was rigidly adhered to from the beginning, unanimity being required for all decisions. Hellwig's strong personality however, reportedly gave him a great, perhaps decisive, influence over the agency.

In the JEA the two sides seemed to function well together, although the American engineers were in general more technically experienced than their counterparts. In the JDT however, the situation was not as bright. Engineers were scarce in Germany, good ones being even scarcer. The DEG companies found it difficult to convince people to move to Augsburg. Those that went kept returning to their firms to keep their bosses informed, to get instructions, and "to be seen". After all, that's where their salaries came from.[18]

Another problem impinging of the JDT's functioning was the negative repercussions emanating from the previously referred to issue over employee's proprietary rights between German government and industry which occurred as the teams installed themselves in the new office space. As furniture was being moved into space allocated to the JDT, workmen arrived and erected a partition the length of the hall. GM was informed that until the German government signed a contract with DEG affording suitable financial protection for the proprietary rights of the DEG firms and their engineers, the wall would stay up and designs would be closely held. Technical discussions were at arms length and guarded. The Americans were shocked, as was Hellwig. The German government

only succeeded in getting the wall down in late November after the necessary agreement was finally signed. But the damage was done and a greater than necessary psychological barrier continued to exist.[19]

4. Selecting a Design Concept

Though Hellwig had influence, he was not able to convince the United States to give up or modify those requirements he felt were wrong. The Americans felt that he was pressing the case of the German firms rather than championing his own ideas. But this was inherent in German government's approach to defense contracting. Had there been 1 governental boss at the top, Hellwig could have asserted his influence. But with two program managers—each with his own industry to look out for—it was not possible.[20]

GM brought as their contending concepts the ideas around which they had written their proposal to the United States. What they faced on the other side were four different concepts each vigorously pushed by the German proponent firms. As a result there were four members of DEG disagreeing and fighting between themselves. Moreover, the German JEA couldn't force a compromise German proposal—too much was at stake for the firms.[21]

The program managers were helpless to make a decision without a recommendation from the JEA. After several months, it became apparent that there was no hope of completing a preliminary design in the 5 or 6 months originally planned. Each firm continued to defend its own designs. Those German firms with candidate components resorted to active "horsetrading". In addition, it was dif-

ficult to get details of the German designs for objective analysis because of the secretiveness of the DEG engineers.[22]

In December the preliminary results of a parametric design study became available, and showed that two similar concepts, a German and an American one, were the most cost-effective. The PMB instructed the JEA to combine the best features of the two concepts that showed up well in a parametric design/cost-effectiveness study. But, 'What were the best features of both?' 'Who would decide?'[23]

Trapp convinced Hellwig on a compromise concept with the driver in the turret in order to lower the silhouette. The JEA then forced design acceptance by the JDT, but only after agreement at the PMB level to divert joint funds to further develop some alternative German components proposed by DEG.

The JEA recommended a concept, which after approval by the PMB in March, led ultimately to an optimistic public announcement by McNamara and von Hassel. When McNamara and von Hassel met in May 1965 and confirmed the concept decision, a news release after the meeting stated:

> The German Ministry of Defense and the U.S. Department of Defense announced today that the MBT-70 program has progressed to the point that a single design concept was agreed upon last week to meet the objectives of a quantum improvement in tank fire power, mobility, and protection... In the light of excellent progress the two ministries are developing presentations on the tank concept and future developments-production timing for those NATO countries having an interest in the MBT-70.[24]

The design concept had been chosen, but not the components.

> "As long as the competing components could be differentiated on the basis of nearness to completion, a choice could be achieved. But when a selection had to be made on the basis of judgment, experience, basic philosophy, or other subjective criteria under the pressure of heavy national interest, no choice was made, and parallel development was agreed on."[25]

Trainor cited differences in the two nation's approaches to testing as another contributing cause to the loss of a considerable amount of time early in the program. Since the U.S. concentrates more on extensive component testing, while German policy gives greater emphasis to system-level testing, much time was consumed negotiating design changes and procedures for their validation.[26]

At the same time that component selections were made, design responsibility, previously centered in the JDT, was divided up. It had been originally expected that the tank would be developed in the JDT, but by mid-1965 development responsibility had been shifted to industry on a component basis. This left the JDT with responsibility for the design of the outer hull and turret and the bookkeeping task of maintaining the master drawings.[27]

> "With the... optimistic public announcement of concept selection those government officials not directly involved in the day-to-day activities could assume that all was well. But behind the facade the internal tensions had already weakened the seams holding the program together."[28]

It having taken 15 months to hammer out a design concept instead of the five planned, in May 1965 Dolvin had to request additional funds.

> "Costs had risen not only because of delays, but also because the cost-effectiveness study had not been included in the original estimate. Neither had provision been made for the extensive competitive studies and subsequent parallel developments. The PMB raised

the total cost estimate to $138 million in August 1965 but did not change the overall schedule.[29]

5. Other Joint-Design Problems

> "DEG, GM, and the components developers, now officially freed from "control" of the JDT, began all-out efforts to win the parallel development competition and assert the superiority of their designs. Agreements that GM thought it had made with DEG were constantly brought up for revision. GM engineers accused the Germans of bad faith, and the Germans accused GM of servility to the U.S. government engineers."[30]

Hochmuth quoted Dolvin on a fundamental problem.

> "The decision-making process was diluted by shared authority and shared responsibility at all levels... There can only be negotiated decisions... This necessitates "compromise" and compromise leaves the door ajar to all sorts of national external pressures and prejudices... ."[31]

Though Trainor found it difficult to ascribe any specific item of sophistication to the joint features of the program, he did feel that these compromises tended to lead to designs that would appease both design groups, the result being greater complexity. In addition, he felt that the 50-50 sharing of development cost contributed to some designers paying less attention to concerns with regards to systems sophistication.[32]

During 1965 the dissension-torn JDT finally gave way to fragmented responsibility between the JDT, DEG and its member firms, and GM. In addition, on the governmental side, after Hellwig left, the bureaucracy at the BWB gradually began to reassert its authority over the German JEA, and this bureaucracy felt little responsibility towards the joint program. But the most critical

changes took place among the systems' users. Germans put a far lower priority on protection compared to mobility than did their U.S. allies. As the tank became heavier and heavier with each component compromise, resistance in the FRG grew.[33]

Yet another design problem can be traced to the attitude changes in the FRG that accompanied its resurgence within NATO. Although there had been no change in the basic tenets of German foreign policy (i.e., heavy reliance on NATO and maintenance of strong ties with the U.S.), during the early 60's: the status of the FRG in NATO had strengthened, and as this occurred, the diffidence and reserve which characterized the FRG several years earlier began to give way to a more independent and assertive attitude typical of the other major NATO member states."[34]

> The German tank of WWII was clearly superior to counterpart American designs. In a similar vein, the German army has been justifiably proud of their knowledge of tank warfare, since the days of Guderian and Rommel. The Germans had a different view from the Americans as to what constituted the ideal tank. For example in the selection of a gun system neither side would compromise and the result was an agreement that each country would produce the tank with its own firepower system. The selection of the fire power system clearly had substantial influence on other aspects of the design.[35]

By 1965, the development and production cost estimates had begun to grow both due to the substantial weight growth and a growing realization that the MBT-70 was much more complex on a per pound basis than contemporary tanks. By the time of its cancellation, the MBT-70 prototypes were to weigh over 55 tons. To further exacerbate these already serious problems there was a gradual

recognition that the planned production quantities and production rates were incompatible with shrinking Army budgets and programs.

On both sides the officers who had reached the initial agreements were now being transferred. As new people were brought in, a questioning of all previous decisions at all levels arose causing considerable problems for the program as a whole.

To quote Trainor another problem was introduced by the fact that...

> The two countries were producing tanks that were enjoying extensive foreign sales while there was no solid evidence of Soviet advances in tank technology that would force an extremely high schedule priority on the MBT-70 program. Consequently, there was a tendency for the two countries to attempt to redesign the system more than would have been the case if there had been a higher priority on system deployment.[36]

Consequently, Krauss-Maffei saw the MBT-70 was going nowhere at about the same time the first Leopard I tank rolled off the production line in late 1965. With strong allied interest in the Leopard I surfacing, Krauss-Maffei started taking ideas from the MBT-70, and began thinking of a Leopard II.

On the government side both the German officers and the civilian officials began to wonder why they had ever agreed to a 1970 date for the replacement. The Leopard was good until 1974 at least, and probably well beyond.[37]

6. Development and Production of the Pilot Tanks and the Collapse of the Program (1966-1970)

By the end of 1965 program slippage had yet to be recognized.

By June 1966 the JDT announced that the design effort for the first pilots was complete, and the move to Detroit began and was completed by September. Though its responsibilities were reduced, the JDT was still to be responsible for keeping track of the overall design.

In June 1966 Dr. Englemann was replaced as program manager by Brig. Gen. Dr. -Ing. H. Schoenefeld. Gen. Dolvin was routinely reassigned in November and replaced by Major Gen. E. Burba, a distinguished armor officer but one evidently with no experience in research, development, production, or procurement.[38]

The agreed-on estimated cost rose from $130 million to $200 million by late 1966. Simultaneously, the delivery of the first pilots was postponed to July 1967 and the first production to December 1970—a year later than originally planned.[39]

In July, the first pilot tank was delivered by GM; and in September DEG turned one out. But, they were bare. The fire control system, the loader, and a host of components were missing, the designs only being 85 percent complete.

As a vehicle the tank performed superbly. Despite its weight and size it had amazing agility and speed.

> "All who observed it were impressed. But, resistance to the increased costs was growing in both countries. The German users were losing interest, unhappy about the weight and other compromise characteristics, and above all unhappy about the estimated production costs. Meanwhile the Leopard continued to gain favor in Germany and abroad."[40]

The program suffered a severe blow in 1967 when Harold Quandt met an untimely death in a plane crash later in September. Hellwig had termed Quandt the "soul" of the DEG.

As the pilot tanks were put through their paces, the inevitable problems showed up.

> "Each side took comfort in the problems of the other... Each vigorously sought to make sure the other side's components rigidly lived up to the specifications and pressed the development of its own backup components where they existed."[41]

The weight of the tank was now about four tons over the agreed limit. The United States maintained this was acceptable, but the Germans insisted on reducing the weight, i.e., a major redesign. The FRG Program Manager felt that continued progress was very seriously endangered. Unable to agree, the two program managers referred the matter to the ministerial level.

The Assistant Secretary of the Army and his German counterpart would not admit failure and decided to continue the program. After intensive exploration of the technical and financial alternatives, they agreed on:

a) A single tank, weighing just slightly more than the previous maximum.

b) Slipping the first production date to 1973.

c) Increasing the joint costs to $303 million with $165 million of that shared, not 50-50, but in proportion to the tanks produced by each country.[42]

To meet the weight requirement, the radiological armor was reportedly deleted from the design. Thus a fundamental requirement of the original concept had been sacrificed, representing a political decision imposed from the top. From the German military viewpoint, the principal reason for making a tank heavier than the Leopard was to have radiation-resistant armor.

> Poorly served by a structure which could not satisfy either party and which paralyzed both so that the resources could not be controlled or marshalled to meet either of the natural goals, the program was failing. In September 1969, Deputy Secretary of Defense, David Packard, alarmed by the estimated procurement costs of the tank after development, asked for a thorough review of the program. One outcome of this study was an estimate that the cost to completion would be $524 million.[43]

On January 20, 1970, a few days after the date originally planned for the first production tank to roll off the assembly lines, a press release from the Department of Defense signaled the end of the joint venture, announcing:

> ...The Army will reorient its Main Battle Tank development program... The modified binational program involves some revision of the joint development relationship through which the U.S. and the Federal Republic of Germany have worked on the tank since 1963. Each country will now assume unilateral technical decisions and unilateral funding...[44]

Whereupon the FRG shifted its development efforts over to a Leopard II design.

The Leopard II, far less complex than the MBT-70, was developed drawing heavily developments generated in the joint program. The U.S., on the other hand, elected to continue unilateral development of an austere variant of the MBT-70. This lasted for almost 2 more years, at which time it was terminated under the fire of Congressional claims that this austere variant of the MBT-70 was overly sophisticated and unnecessarily complex.*

Viewed in retrospect, most of the problems of the MBT-70 program were not uniquely related to the bilateral development features of the program, most of its problems were exacerbated by joint development

For example, the 1974 GAO study entitled, Benefits and Drawbacks of U.S. participation in Military Cooperative Research and Development programs with allied countries. singled out one such point of exacerabation, the difficulty of harmonizing differences in military equipment requirements; as being one of the MBT-70's major stumbling blocks. Continuing, it summarized as to how attempts at harmonization led to ever greater complexity and finally U.S. withdrawal.

In the case of the main battle tank (MBT-70) program,...harmonizing was a problem before and after the program started...the cooperative agreement provided for a degree of commonality with each country having a different version, the U.S. version being more sophisticated. As development proceeded, several amendments were made to the cooperative agreement, each change resulting in less commonality. Finally, the United States pulled out of the cooperative program.

As important as this problem was though, the fundamental weakness lay elsewhere.

7. Hochmuth's Conclusions on Structure and Strategy

> Had there been one master strategist charged with the successful implementation of the MBT-70 program at the outset, what might he have done?[45]
>
> The ideal director would have understood that the specific goal of developing a tank had antecedent higher-level goals that were disparate, and he would have made certain that his actions reinforced his power by increasing the congruity of his objective with the higher-level goals. The United States wanted and needed a tank by 1970, but Germany really didn't. The decision, the impetus, reflected U.S. needs, U.S. desires to economize, U.S. desires to strengthen NATO. ...It was not the decision of entrepreneurial leadership or some other goal-setting process based on calculation. It was based purely on aspiration. ...The U.S. legal expert who was termed the 'architect' of the original agreement by the top German negotiator, had been involved in several co-production programs, including the HAWK, but always apparently as a drafter of agreements, never as an observer of how they really operated. The Germans were following the U.S. lead in such matters at that time. ...Germany acquiesced for political reasons and a desire to get new technology, particularly in the fire control and radiological areas, although the Leopard was meeting her tank requirements for the 1965-75 period.[46]
>
> But there was no one master strategist. There were two program managers with separate resources and separate pressures to worry about. Because they had to seek consensus, and because the very nature of their formal responsibilities required them to protect the interests of their separate institutions, they could not reach a decision a concept (sic). They abdicated in favor of a computer. The computer supposedly would provide a 'rational', neutral, and objective decision which each program manager could use to justify the concept selected to his own people. From the beginning, by inadvertent design, the strategic arena was not that of a single management shared by two mutually reinforcing individuals. Rather the program became two arenas in which two strategies were played out in such a way as to hinder each other.[47]
>
> There was still hope when the JEA was formed that an integrated team could effect a program-wide strategy. But though the Americans and Germans sat in the same offices, it was abundantly clear that their bosses were their national bosses.[48]

Prisoners of their national interests, the dual program managers were helpless to intervene effectively when the firms began to maneuver to get their individual concepts and their components selected.[49]

If DEG had been a solid cohesive firm with a reputation and goodwill to protect, there might still have been a chance to work something out with GM. Or, if GM had been given systems management responsibility, the firm might have forced a workable arrangement.[50]

The JEA, lacking a chief, became a combined gentlemen's boxing ring and information exchange.[51]

The contractors were given separate contracts with different incentives and even different fee schedules for similar work.[52]

There remained the JDT as a possible strategic catalyst. After July 1965 when the concept had been chosen and the components allocated, the JDT could have provided strategic direction. But again the members all were paid by their companies and would have to go back one day. The mutually agreed work assignment gave to the JDT responsibility for systems type problems including design proposals and to the prime and subcontractors the responsibility for accomplishment. This required that the JDT be given systems management and therefore the authority to direct the contractors. But the JDT was divorced from contractual, accounting, and payment functions; and lacking these normal business tools had to rely on the good will of both prime contractors to accept its direction...[53]

There was no strategy. The structure of the program guaranteed that there could not be.[54]

1 Milton S. Hochmuth, Organizing the Transnational: Experience in Transnational Enterprise, A.W. Sijthoff, Leiden, the Netherlands, 1974, pp. 103-4.

2 Ibid., p. 99.

3 Richard J. Trainor, Barriers to the Transfer ot Systems Technology to the United States, Director of Systems Review and Analysis office, Headquarters, Dept. of the Army, 1975, p. 3.

4 Hochmuth pointed out that there were two important differences in this otherwise analagous set of events. One, whereas with the signing of the MOU, the U.S. negotiators from Paris who had spent months drafting it faded completely out of the picture, in the FRG there was less discontinuity between the negotiating team and the officials charged with implementation. In addition, the U.S. representatives involved in the 1962 to 1963 negotiations leading up to the MOU were mostly from the U.S. delegation to NATO, there being no evidence that any experts from U.S. agencies that would be charged with execution of the program or be the ultimate users were present. Secondly, while the project manager concept had become common place in the U.S., this was not the case in the FRG where the move was greeted with little enthusiasm at BWB (Hochmuth, op. cit., p. 105-7).

5 Hochmuth, op. cot., p. 108.

6 Ibid.

7 Trainor cited this selection of an inexperienced contractor for these studies as a contributing factor to the inaccuracy of the early cost and weight estimates of 1963 and 1964 (Trainor, op. cit., p. 3).

8 Hochmuth, op. cit., p. 108.

9 Ibid., p. 108

10 Trainor, op. cit., p. 3.

11 Ibid., p. 4.

12 Hochmuth, op. cit., p. 112.

13 Ibid., pp. 113-4.

14 Ibid., p. 109.

15 Ibid, p. 109. NATO published a study in 1976 prepared by AC/94 Working Group on Industrial Property, entitled, "Regulations in NATO Countries Concerning Employee Inventions."

16 Hochmuth, op. cit., p. 109.

17 Hochmuth op. cit., pp. 113-114.

18 Ibid., p. 115.

19 Ibid.

20 Ibid., p. 116.

21 Ibid.

22 Ibid.

23 Ibid., p. 117.

24 Quoted from Hochmuth p. 101

25 Hochmuth p. 117, quoting Gabbe

26 Trainor, op. cit., p. 4

27 Hochmuth p. 118

28 Ibid.

29 Ibid p. 119

30 Ibid., p. 118

31 Ibid., pp. 118-9

32 Trainor, op. cit., p. 3.

33 Hochmuth, op. cit., p. 119.

34 Ibid., p. 102.

35 Trainor, op. cit., pp. 3-4

36 Ibid., p. 4.

37 To reinforce this point, in 1978 Canada selected the Leopard I for its forces in central Europe.

38 Hochmuth, op. cit., p. 120.

39 Ibid., p. 121.

40 Ibid.

41 Ibid.

42 Ibid., p. 122.

43 Ibid., pp. 122-3.

44 Comptroller General, op. cit., p. 22.

45 Hochmuth, op. cit., p. 123

46 Ibid., pp. 123-4

47 Ibid., p. 124

48 Ibid.

49 Ibid.

50 Ibid.

51 Ibid.

52 Ibid.

53 Ibid.

54 Ibid.

C. AVS (U.S.-FRG V/STOL FIGHTER PROGRAM)

1. Background

In 1961, the NATO Basic Military Requirement (NBMR) #3 project was initiated as an attempt to find an alliance-wide solution to a common requirement for a VTOL light strike reconnaissance aircraft for the NATO Air Forces. In January 1962, NBMR 3 ended in an impasse after which each competing nation pursued its national project(s) on its own.[1] The French continued with their VTOL Mirage II,[2] the British with their VTOL Hawker P-1127 (which eventually evolved into the Hawker Siddelley AV-8A Harrier and later the McDonnell Douglas AV-8B Harrier), and finally the U.S. and FRG with their respective efforts which will be covered shortly.

2. Organization

Unlike the purely unilateral approach of France and Britain, the U.S. and the FRG decided to establish a working group to study the feasibility of combining their separate V/STOL fighter aircraft projects into one joint development project. This was part of the wider effort to launch joint development projects that would pick up where the existing joint production projects were about to leave off. (The American-German MBT-70 was the other major trans-atlantic project emenating from this effort. All the successful ones, however, were to exclude the U.S.) The study group recommended that the program be undertaken jointly and consist of three distinct phases: Conceptual; Prototype Definition; and Acquisition. At the conclusion of each phase a new

joint agreement would be signed prior to proceeding to the next phase. The first phase commenced subsequent to MOU's dated August 1, 1963 and February 5, 1965. In addition, there was an International Agreement on Cooperation in R&D for V/STOL aircraft signed on November 14, 1964.

Within the NATO Armament Committee (replaced by CNAD in 1966), the U.S. and FRG's Senior National Representative (SNR) coordinated policy for the project. Under them came a joint study group, and later, one for joint evaluation.

Development costs were to be shared on a 50 - 50 basis, but work sharing was expected to be somewhere around a 60 - 40 ratio in consideration of the U.S.-FRG troop offset arrangements. The two nations agreed that English would be the official language for the program and the Anglo-Saxon system of weights and measurements would be used.[3]

The ultimate weapon system was to be a V/STOL tactical fighter aircraft with the following capabilities:

(1) All-weather, low-level, high-speed penetration, for delivery of either nuclear or non-nuclear ordnance at medium ranges.
(2) Air-to-ground strikes in support of ground combat operations at short range.
(3) All-weather, low-level, high-speed penetration reconnaissance and/or strike reconnaissance at medium to long ranges.
(4) Air-to-air combat of a self-defensive nature.[4]

The engines for the fighter were covered in an independent parallel program involving the joint funding by the U.K. and the U.S. of the Pegasus engine (later to power the Harrier). The Rolls-Royce/Bristol Siddeley Pegasus was a vectored-thrust vertical-lift engine and had represented a breakthrough in turbojet engine design.

The Pegasus engine dates back to 1957 when the U.S., through its Mutual Weapons Development Program (MWDP), provided funding to Britain's Bristol Siddeley corporation for its development. One estimate put the U.S. contribution through 1965 at $26 million or 56% of the total development cost. On October 20, 1965, the U.S. and U.K. signed an MOU for the development of a direct lift engine for V/STOL aircraft.[5] The U.S. contracted with the Allison Division of General Motors and the U.K. contracted with Rolls-Royce. A joint Project Board and an Industrial Program Manager for the vertical lift engine provided support to the U.S./FRG V/STOL project.[6]

In addition, two other U.S. contractors, Pratt & Whitney and General Electric, were both engaged in a contract definition competition for a lift-cruise engine that would be applicable either for the AVS project or the USAF's FX and the USN's VFAX projects.[7]

3. Design Study Program

There were two German contractors, and eventually two U.S. contractors, submitting proposals during the Design Study phase. Each country was to hold its own source selection with the understanding that its selectee must be able to

work with any one of the contractors from the other country.[8] Subsequently, the joint evaluation group was to select the best design characteristics from any or all proposals submitted and come up with a single configuration.

Whereas VTOL activity died down in the U.S. after the NBMR 3 impasse in January 1962, the German aerospace industry (along with the British and French) had continued its national programs.

The two firms selected by the German Defense Procurement Agency, The Bundesamt fuer Wehrtechnik und Beschaffung (BWB), were VFW GmbH and Entwicklungring Sued (EWR) GmbH. Both EWR and VFW were brought under contract in late 1963. Messerschmitt had previously developed and flown its VTOL VJ-101 prototype, and VFW its VAK-91 prototype. EWR, a jointly owned subsidiary of Messerschmitt, Boelkow and Siebelwerke took over the VJ-101 from Messerschmitt in 1964.[9]

EWR had a staff of about 250 working on the AVS alone, with an additional but smaller staff supporting F-104G reliability and maintainability efforts. Most of the AVS staff was to later reappear in the MRCA Tornado project, providing the core personnel. Representative of this, EWR's AVS Program Manager was Gero Madelung, later the MRCA's third Program Manager, and AVS Deputy Program Manager was Helmut Langfelder, the MRCA's second Program Manager.[10]

In the fall of 1964, Boeing was given the first of three subcontracts by EWR to provide technical support. Manning levels for the Boeing team in Munich working with EWR started out at seven people in October 1964, and increased to

14 the following month with the signing of the intergovernmental MOU. In January 1965 Boeing received its second subcontract and its Munich detachment stabilized at approximately 40 people between May 1965 and January 1967. EWR, for its part, had a small team averaging around a half dozen men in Seattle during this period.[11]

The rationale behind the teaming up of the two firms was relatively simple. Both firms could see the NATO-wide VTOL interest in fighters. On EWR's side, Boeing, as one of the world's leaders in aerospace and as one third owner of Boelkow, was a logical choice for a partner for its first post-war fighter design effort. Boeing for its part, was interested in getting back into the fighter business (the last Boeing fighter to enter series production dated from the 1930's).[12]

As the U.S. side of the project came on stream later than that of the FRG, Republic-Fairchild entered the picture in early 1966.

Reflecting a similar but looser teaming relationship between the other two firms, Republic-Fairchild sent a team to VFW (Bremen) in early 1966, be it a smaller one than the Boeing team. VFW also sent a small group over to Republic-Fairchild in the U.S.

The tight EWR-Boeing collaboration not surprisingly led to considerable cross-fertilization, so that in the end, among the four designs presented in late 1966, the EWR and Boeing designs were virtually identical. The U.S.A.F. took exception to this and at the last minute Boeing was required to revise its

proposed design. In the end the EWR design was judged by the two Air Forces to have been the best of the four.[13]

Although this would eventually present the U.S.A.F. with a dilemma, it was cognizant of the close EWR-Boeing relationship throughout, and even encouraged it. Moreover, the USAF SPO requested both U.S. contractors submit, as an element in their proposals, their teaming arrangements. Republic-Fairchild had taken another tact than that of Boeing's, however. Feeling this represented an endorsement of collusion that threatened to bias the competition, they let it be known they would protest on these grounds if the Boeing design was selected. The Source Selection Evaluation Board had trouble dealing with this rather ticklish issue, and opted not to score this part of the proposal, only noting it. Thus Boeing's successful teaming relationship served, in the end, as a penalty in yet a second way.[14]

The January 1967 parallel source selections following a joint evaluation by the SPO, led to the award of a $6 million contract by the USAF's ASD to Republic- Fairchild and a comparable award to EWR by BWB for the prototype definition phase. By the month following source selection Boeing scaled down its 40-man team at EWR to seven (which continued to support EWR under a third subcontract), while Republic-Fairchild built up its team at EWR to about 70 to 80 men. As a residual of the tight EWR-Boeing relationship, and the Boeing content in the EWR design, the Boeing team in Munich gradually tapered off during 1967 and into early 1968.[15]

An agreement had been reached early in this phase allowing each country's representative to have unlimited access to all data generated and submitted to the joint study group.[16]

One of the important deficiencies of the project, which appeared during this phase and continued through to cancellation, was to be the lack of a definition of the system's operational role.[17]

4. Prototype Definition Phase

On April 12, 1967, the individual national efforts, i.e., the German Study Group and the U.S. project personnel, were combined into a single group known as the U.S./FRG V/STOL Tactical Fighter SPO (and the SNR established a project steering committee). Also in April 1967, the German and American contractors set up EFJ, headquartered in Munich.[18]

During the Prototype Definition phase EWR and Republic-Fairchild jointly developed a detailed plan for contractor production of the prototype aircraft. This plan called for the assembly of seven prototypes in the U.S. and five in the FRG. The estimated cost of this stage was $500 million.

By June, 1967, interest within the two customer governments seemed to be drifting toward a more limited prototype program, rather than committment to a production program.

When the evaluation report of the Prototype Definition phase study was completed in late 1967, it indicated that the contractor had satisfactorily

accomplished the objective of defining general system design and performance specification. This was qualified, however, by the statement, "the contractor's Definition phase final report revealed some omissions and treatments in less depth than was expected." Since this was the contractor's initial proposal, it was generally felt however, that these deficiences could have been resolved through negotiation between the SPO and the contractor so as to insure the quality needed by the Acquisition Phase contract. Instead, in January 1968, the Steering Committee decided to cancel the program for an assortment of reasons to be discussed in Section 5 of this sub-chapter.

The principal technical deficiencies of the proposal involved a need for additional analysis in the engineering and technical spheres concerning reliability and maintainability, plus a need to further refine cost estimates. The first two problems of reliability and maintainability were particularly significant for such a V/STOL aircraft since it would be operating from dispersed and unprepared sites, and thus requiring a high degree of self-sufficiency.

Another problem concerning cost estimation involved an apparent unwillingness of the contractor to share cost risk and its use of an inappropriate learning curve. These, however, were not the primary reasons for the project's demise.[19]

5. Cancellation and the Issues

The SPO was in the process of validating the final reports of the Prototype Definition phase submitted by the contractor EWR, when the U.S./FRG Steering

Committee decided on January 29, 1968 not to enter the Prototype Acquisition phase. The reasons given by the U.S. for the project's termination were that increasing monetary constraints created by the operational demands of the Vietnam War were limiting R & D projects, and that the USAF had not established an operational requirement for the aircraft. Consequently, the SPO and the program were disbanded by June, 1968.

The lack of a firm USAF operational requirement had haunted the project from the beginning. The Luftwaffe's interest in a VTOL fighter had been stronger than the USAF's, but was conditional on having a NATO partner. The Luftwaffe had no plans to go it alone. Boeing, and later Republic-Fairchild, attempted to integrate the technology into a specific design, and pursuade the USAF that such an aircraft was needed. The USAF kept edging up to the line, producing draft Required Operational Capability (ROC) documents, but wouldn't cross over.[20]

a. <u>On the Plus Side</u>

One objective that was stated as applying to the program generally, but was not explicitly stated as such in any one of the phases, was the goal of advancing the technology of both nations. The U.S. advanced its technology through the investigation of V/STOL concepts as applied to fighter aircraft, while the FRG received valuable knowledge in jet engine technology.[21] EWR went on to use the design staff and knowledge to jointly design, develop and produce the Tornado multi-role combat aircraft (MRCA) with the U.K. and Italy.

Another accomplishment of the program was its promotion of the on-going exchange of V/STOL technical data between the two countries. When the program terminated, the two countries agreed to a semi-annual conference where researchers from the AFSC V/STOL Technology Branch would exchange data with their counterparts in the Luftwaffe.[22]

The 1976 GRC study cited the AVS project as an example of the valuable intermediary role that SPO can play in improving communications and facilitating the work of industrial firms in a collaborative development project. The SPO was located at Wright-Patterson AFB, Dayton, Ohio, and incorporated about 20 German engineers. "One of the bright spots of this ill-fated prgram was the smooth functioning of government and industry people at the technical level."[23]

Yet another plus for the project according to Baas, was German government and industry having obtained valuable insight from its U.S. partners (first Boeing from 1964-1967 and then Republic-Fairchild from 1967-1968) into the systems approach to the design and development of complex weapon systems. The U.S. Government and its aviation industry had developed sophisticated management and production practices that had been proven in past programs. The German participants were therefore introduced to advanced management concepts, and the knowledge acquired in the U.S. in systems development.[24] In the words of one Boeing engineer assigned to the EWR technical assistance team, "German government and German industry got out of it 80% of what they wanted in both technology transfer and systems management know-how".[25]

Three additional justifications for pursuing the project were that: it complemented the U.S./U.K. Pegasus engine effort; it would probably have had some net Balance of Payments (BOP) benefits for the U.S.; and it would contribute to the increased standardization of the two countries' equipment. But since the project never advanced beyond the paper studies phase, these obviously came to naught.[26]

b. Reasons for Terminating

One factor contributing to the demise of the U.S./FRG V/STOL fighter program was "not invented here" (NIH) syndrome. As a means of minimizing competition head-on with the highly developed U.S. industrial base, European industries began actively seeking out in the early '60's those special fields wherein the U.S. had expressed little interest. One of these in which a large amount of development work had been accomplished by the Europeans was VTOL aircraft.[27] Considerable criticism was directed at the U.S. for not taking advantage of this know-how through direct purchase or license agreements, but rather learning what Europe had already learned. In any case, with the decision in the early '70's to directly purchase the AV-8A Harrier from Britain to provide the U.S. Marines with a VTOL fighter, plus obtain a complete data package for further development of that system (the AV-8B), as well as produce the Franco-German Roland II missile system under license, the U.S. attitude belatedly began to show signs of change on this point.

One underlying reason for the program's termination was reportedly the reluctance on the part of the Air Force, with some backing in DDR&E, to place the

development of a front-line fighter in the hands of another country. This concern involved both considerations of security and the difficulties anticipated in international R&D.[28] Just compare this project, or the MBT-70 for that matter, with the successful NATO Seasparrow project, where the DoD was willing to risk joint engineering development and production of an improved version of the USN (Basic) Seasparrow system (with only about 10% European content).

An additional factor, which is probably the most important single factor contributing to the program's demise, was the DoD's budget scrimping on all non-Vietnam-oriented programs. This resulted in the DoD's curtailing of several high-risk research projects, including the V/STOL fighter and an Army competition for a high-speed helicopter.[29] Although less important, the FRG, as well, was experiencing financial problems at the time. The Ministry of Defense was feeling this strain and was reducing its research expenses in favor of operating expenses and the direct purchase of U.S. military equipment (e.g., the F-4 Phantom covered in Chapter 11).

Finally, there are the implications of the lack of an operational mission, a point already covered under the Design Study phase. Neither during the Design phase nor the Prototype Definition phase was there any evidence that the USAF had defined an operational mission for a V/STOL fighter aircraft, a condition which persists to this day. This lack of definition contributed to the complexity of the aircraft which the industry-government team was attempting to design. The engineers had to design an aircraft that would possibly be used in interdiction, close air support, and reconnaissance roles. The concept of

dispersal with minimal support further increased the need for a complex aircraft. But this complexity in turn resulted in decreased reliability and maintainability which either increases the quantity required, or increases the need for logistic support. These alternatives proved to be both expensive and working at cross-purposes with the original concept of concealment and mobility.[30]

6. Summary

According to the Baas study the program cannot be considered a complete failure. Part of its objective was to advance technology and promote the exchange of data, both of which were accomplished, though the desirability of the latter point was somewhat debatable as far as the Germans were concerned. The German government, along with Messerschmitt and Boelkow, also obtained valuable insight into the systems approach to design and development of complex weapon systems. This was transferred directly to the subsequent Tornado MRCA effort.

The difficulties of the program, which in any event never had more than lukewarm backing in the U.S.,[31] can be classified as financial and technical.

Probably the most important single factor contributing to the program's early demise was the U.S. defense budget being stretched in order to support the war in Vietnam, causing R&D efforts to be curtailed. The cost of the proposed program was highly uncertain with the government and industry differing as to the amount and the sharing of risk. The FRG was also forced to reduce R&D

funds so as to assist in offsetting the cost of maintaining U.S. troops in the FRG.[32]

The technical difficulties stemmed from the USAF's inability to define an operational mission for a V/STOL fighter. The anticipated problems in reliability and maintainability were a result of the complexity of the aircraft design. And finally, there was strong feeling in the U.S. and the DOD towards procuring only weapon systems of U.S. origin.[33]

And as one final point, the teaming of firms from different nations prior to a common source selection surfaced a critical issue for joint design and development projects where the U.S. is one of the participants. The issue emanates from the differing U.S. and European competition policies (generally speaking, structural versus behavioral) and especially as they apply to defense procurement. The USAF's dilemma and the reversal of its position on the Boeing- EWR (i.e., Messerschmitt-Boelkow) teaming relationship in the final days of the competition provides yet another example of the difficulty of finding a good fit when the U.S. is a partner in a joint design and development project.

7. Sequel

As the FRG was depending on the AVS program (at least originally) to provide its next generation fighter, a feasible design and partnership was required to replace it. Fortunately for the Germans, the British as well had found themselves in a similar situation with half a fighter program, after the French had dropped out of the two year old Anglo-French Variable Geometry (AFVG) air-

craft project in mid-1967. Discussions began in May 1968 between the British and German governments (joined by several others) in Brussels within a NATO working group and led to the signing of an MOU later in the year. The new aircraft was to be Multi-Role Combat Aircraft (MRCA) Tornado (See Chapter 8).

Meanwhile the intra-German and interallied partnerships established during the AVS project were to have a decisive long-term impact, in parallel with the launching of the MRCA project. Consolidation of the German aerospace industry had proceeded with the owners of joint EWR subsidiary finally making the plunge. Messerschmitt, Boelkow and Siebelwerke merged in mid-1968 to form Messerschmitt-Boelkow which, now compliant with the German government's demands for concentration of the aerospace industry, was designated by the government to be the German partner firm in the new joint project, the MRCA Tornado. Furthermore, MB's selection to be the German industrial participant was the result of its having won the prior AVS competition. This in turn was the fruit of the intense collaborative relationship built up over the 1964 to 1967 period with Boeing. The year following the MB merger and the launching of the MRCA Tornado project, 1969, the consolidation efforts took another step further with MB-Hamburger Flugzeugbau (owned by the Blohm family) merger to form MBB.

The other AVS partner, the U.S. Government, followed its own course which indirectly led to another joint VTOL fighter project involving the U.S. and the U.K. during the 1970's. Though a VTOL mission never did surface in the USAF, another service, the U.S. Marine Corps, did have a requirement for a VTOL ground support fighter. In 1971 the USMC bought into the British AV-8A

Harrier program with a purchase of 110 aircraft and the technical data package. The Pegasus engine utilized by the Harrier was the fruit of an earlier joint U.S.-U.K. effort interrelated with the AVS. After a series of joint and unilateral improvement programs the two governments went forward in 1981 with the 400 aircraft AV-8B Harrier program (See Chapter 9).

1 See Chapter 5 for a description of the ill-fated NBMR procedures (1959-66) and a short history of NBMR 3 in particular.

2 The Mirage II flying test bed/prototype underwent a short history of considerable hover and flight testing prior to its crash in the summer of 1962. Deficiencies centered on the flight control system and engine instability. Following the crash, Dassault built a new and larger VTOL aircraft, the Balzac, which though externally similar to the Mirage II was a completely different aircraft.

Back in 1959, Dassault and Boeing had signed a technical exchange agreement on VTOL aircraft. Boeing had been doing considerable wind-tunnel testing on a design similar to Dassault's Mirage II. Over the following three years Boeing provided Dassault with wind-tunnel test data in exchange for Dassault's flight test data. The agreement proved to be a very beneficial one from both firms' viewpoints. (Source: Tom Lollar, one of several Boeing engineers involved in the effort.)

3 Capt. Melvin T. Baas, United States Involvement in Co-development: An Analysis of the US/FRG V/STOL Fighter Aircraft and NATO Sea Sparrow Project, a thesis presented to the Air Force Institute of Technology, August, 1971, pp. 26 and 32.

4 Ibid.

5 This issue resurfaced in the fall of 1971, during negotiations between the U.S. and U.K. Governments, and Rolls-Royce (having since absorbed Bristol Siddeley) and Pratt & Whitney and General Electric, over the licensed production of the Pegasus 11 (powering the AV-8A Harrier) and a joint license-development program based on the Pegasus 11. The U.S. Government claimed it retained limited proprietary patent rights to the Pegasus engine from the previous MWDP funding. This issue took several years of negotiations at the governmental level to resolve. (Aviation Week and Space Technology, October 8, 1971, p. 16).

6 Baas, op. cit., pp. 17-18.

7 "Cancellation of U.S./German V/STOL Fighter Won't Hinder Important Lift/Cruise Engine," Aerospace Technology, Feb. 12, 1968, p. 12.

8 Baas, op. cit., p. 23.

9 Interviews with Robert E. Kesterson, U.S. Roland Marketing Manager, Boeing Aerospace Company., February 1982, formerly of the Boeing AVS engineering staff in Munich from October 1964 to January 1968.

10 The first MRCA Program Manager was Ludwig Boelkow himself.

11 Kesterson, op. cit.

12 Ibid.

13 Ibid.

14 Ibid.

15 Baas, op. cit., p. 23.

16 Ibid., p. 24.

17 Ibid., p. 28.

18 Ibid., p. 17.

19 Ibid., pp. 28-30.

20 Kesterson, op. cit.

21 Baas, op. cit.

22 This point was evidently somewhat debatable. A contrary view was expressed in the FRG a year after the project had ended--a view which also is a good example of the sensitivity of the issue of data exchange. At that time the next generation of fighters was expected to be V/STOL. This was a field in which the FRG had done considerable research and operational testing. In the words of the one official, "We exchange all our V/STOL information with the U.S. We are very much afraid that eventually we will be buying back our own know-how." "U.S. Pressure Against European Fighter Seen", Aviation Week & Space Technology, January 13, 1969, p. 20.

23 GRC op. cit., p. 257.

24 Baas, op. cit., p. 28.

25 Kesterson, op. cit.

26 Ibid., pp. 27-8 and 30-1.

27 Another such area was all-weather, short-range, low altitude air defense systems, i.e., Roland, Crotale, and Rapier.

28 "Cancellation", op. cit., p. 12.

29 Aviation Week & Space Technology, Feb. 12, 1968, p. 27.

30 Baas, op. cit., pp. 33-4.

31 Aviation Week and Space Technology, January 29, 1968, p. 28.

32 Baas, op. cit., p. 35.

33 Ibid.

D. MALLARD

1. The MOU (1967)

The U.S., Canada, UK, and Australia agreed in 1967 to jointly develop a large scale communication system for tactical warfare purposes in the 1975 - 1985 time frame. The system, representing the largest and most involved communications project for tactical purposes seen to date, was to involve a combination of radios, microwave, and satellites, as well as being capable of voice and message traffic (with the emphasis on the latter).[1]

The objective was to procure the system at a reasonable cost for the common use of the Armies, Navies, Air Forces and Marine Corps of the four nations, while taking advantage of the broader base of technology that could be offered by the four national industries during development. A worthy, if overly ambitious objective.[2]

Project Mallard began officially on April 6, 1967, when the Deputy Secretary of Defense signed a tripartite MOU for the U.S., one which Canada and Australia had signed several days previously. Britain, the project's originator, did not sign immediately. The British held out for a commitment for a fixed percentage of Mallard production.[3]

The original MOU included the following key features:

- the R&D effort would be distributed nationally in proportion to their financial contributions.
- patent rights would be shared by the participating nations.

- each nation's industry would have the opportunity to compete for a share of production equal to that governmnent's requirement.

Negotiations continued with the British after the signing of original MOU, and led to the signing of a revised one in September, 1967. Though not successful in obtaining a fixed percentage in the end, the British were satisfied by a compromise provision which involved competition on equal terms with the other three national industries for 50% of the project - with the other half being guaranteed nationally on the basis of the number of systems required.[4]

2. Managing the Concept Formulation Phase (1967-69)

The focal point for direction and supervision of the four national efforts, a Program Management Board (PMB) and the International Joint Engineering Agency (JEA) were set up at Fort Monmonth, New Jersey.[5] The PMB consisted of the four national Program Managers. The JEA was the professional engineering entity which identified and recommended the work to be accomplished, and monitors its accomplishment, particularly from a technical and systems point of view.[6]

Most of the work was accomplished by the four national industries under the direction and supervision of the national and international management and technical authorities. As of November, 1968, over $19 million had been obligated for development work by industry including:

- three major competitive system studies (two by U.S. firms and one by a British firm), and;

- 27 Technique Support efforts directly related to the application of communication/computer technology to the Mallard system.[7]

Hardware companies that were providing competitive recommendations for the ultimate design of the Mallard system, its subsystems and equipments included:

- RCA;
- Sylvania;
- Litton Industries;
- IBM;
- Plessey;
- Marconi;
- Standard Telephone and Cables, and;
- General Electric.

The competing software companies included:

- Hughes;
- Westinghouse;
- Operations Research, Inc., and;
- Planning Research Corp.

A large number of other firms from the four nations were doing Technique Support work.[8]

As of November, 1968, the Program Management Board (PMB) could report that, after 18 months of initial organization and development work on the project; the Concept Formulation phase of the program was completed by mid-1969, and

was followed by the commencement of the contract definition phase, which was expected to be completed by mid-1971, to be followed by engineering development and initial production in 1974-75.[9]

3. The Joint Project Unravels During the Contract Definition Phase (1969-70)

However, by 1969 signs of trouble were beginning to appear as a result of various program difficulties covered below. In reviewing the fiscal 1970 Appropriations Request, Congress asked that the DOD consider the discontinuance of U.S. participation in the project. On October 3, 1970, in the face of continued Congressional objections to the project and a lack of support within the DOD, Deputy Secretary of Defense David Packard announced the termination of U.S. participation in the Mallard project.[10] The program was cancelled as a joint venture the following month, after some 3 years, and for the U.S., an investment of some $34 million.[11]

4. Trainer's Analysis: Lessons Learned

The following 8 points were listed as key problems of the Mallard project by Richard J. Trainor in his 1976 study Barriers to the Transfer of Military Systems Technology to the United States.

(1) Source of Requirement

Instead of originating from an operational requirement identified by the user, the concept's source was the international R&D community, the users being brought in somewhat later. The users representatives having been less

involved early on in the project, is felt to have contributed to its early demise.[12]

(2) Unity of Requirement Community

The Armor, Infantry and Artillery branches of the U.S. Army tend to exhibit considerable solidarity when one of its weapon systems are subjected to criticism. The Mallard program, however, was defended by the Signal Branch, a branch lacking the clout typical of those associated with combat systems. This problem was doubtlessly further exacerbated by the difficulty involved in conceptualizing a complex electronic system.[13]

(3) Requirement Not Specific

The statement of the requirement for Mallard was not specific with regards to frequencies, line capacities, computer capacities and interoperability with related electronic systems. This latter problem was further aggravated by a lack of strong central control of the design of these related systems.[14]

(4) Resource Requirements Not Specified

There was no agreed on estimate for the total cost of R&D or procurement, the phase-in schedule, or how the overall communication system was expected to operate during the long phase-in period.[15]

(5) Other Military Services Not Sufficiently Involved

Mallard was to involve the other U.S. military services, not just the U.S. Army though the Army was to be the largest user and was executive agent for the United States. Even though it is natural that the Army was the principal

provider of manpower, the number of full-time members each assigned to the project office is somewhat indicative of their individual levels of involvement. As of mid-1969 the Army had assigned 109 personnel, the Air Force 13, and the Marine Corps. 1.[16]

(6) NATO Interface

The value of such a system as the Mallard would be principally its use in the event a war in Europe, one which would involve our NATO allies, especially the FRG. Yet, the FRG was not involved in the program. Canada suggested that Mallard be offered to NATO as a cooperative project. Later the UK suggested that the FRG be included as a fifth partner. Nothing ever came of these suggestions, though.[17]

In any event, after the program's cancellation, the need for better tactical communications inter-operability still remained. The prospects for such a project shifted to the NATO level shortly thereafter. The NATO Integrated Communications System (NICS) organization was established the following year, in May 1971. The plan was that NICS would ultimately include a totally integrated automated satellite communications system which could link tactical units through mobile stations sometime in the late 1980's.[18]

(7) Organizational Structure

The organizational structure for Mallard was complicated, undoubtedly the result of the involvement of four nations, plus the four American services. This complex structure most likely contributed to the lack of discernible progress during the first two years of the program. This in turn resulted in

the undermining of the authority of the Mallard Program Manager as higher level staff offices became increasingly involved in program detail.[19]

(8) Congressional Attitudes

Some observers attributed the programs lack of success simply to a lack of Congressional support, but the previous paragraphs provide evidence that there was more to it than just that. Nevertheless, it is true that by 1969 - 1970, the Congressional attitude toward Mallard was decidedly unfriendly. The Mallard project was caught in the wake of Congressional disenchantment with the slippages and cost overruns of the MBT-70 program.[20]

5. Sequel: From Mallard to Tri-Tac and the RITA-based MSE System

As is often the case with these inter-allied programs this was not the end of the matter. With the collapse of Mallard, the US and the UK embarked in 1971 on their own battlefield communications systems, Tri-Tac and Ptarmigan respectively. The British met an urgent interim requirement by using existing hardware from the Bruin system.[21]

The U.S. Army's Tri-Tac was aimed at providing a tri-service tactical communication system which would make use of the existing analog inventory, while at the same time establishing common standards which would permit the use of newer digital technology as it became available.

In the original Tri-Tac system, mobile radio subscriber equipment was to be used only in forward areas where it would be impossible to locate mobile

nodal switching centers. However, in 1982, the US Army discovered that it was practical to use these large containerised nodal switches at divisional HQ level and it was decided to use mobile subscriber equipment (MSE) from brigade HQs down, with the original Tri-Tac units used in the rear echelons.[22]

This change of plan was due in part to the size and weight of these switches, and also as a result of revised operational requirements which were affected by a shortage of skilled military personnel required to operate the original system.

As a result of this change, the original $1 billion MSE part of the program increased to over $4 billion, with a requirement to equip 25 US divisions. In 1983 the US Army called for new bids for this greatly expanded MSE program.

Since no suitable hardware was available from any of the US electronics companies and because of the desire by the Pentagon to get the Tri-Tac program back on course as quickly as possible, the USA was forced to look offshore for a system.[23]

As a result of the Mallard experience and the relatively close liaison between the US and UK military, the US Army based much of its original MSE thought around the single channel radio access element of the Ptarmigan system and at one stage it looked as if the Ptarmigan equipment would be the automatic choice.

Plessey, the prime contractor for Ptarmigan, teamed up with Rockwell and ITT to present its bid to the DoD, while GTE joined with Thomson-CSF to offer a system based on the mobile radio elements of the French RITA system.

The MSE competition developed into one between the more advanced digital technology and largely autonomous single channel radio access element of Ptarmigan, against the field-proven hardware and the relatively high US domestic content of RITA.[24]

Once the decision to adopt elements of one or the other allied system had been made, the much troubled US Tri-Tac system could move back on course. The lengthy detour by the US Army had been forced upon them by the need to change the concept of a major part of the system.

The source selection was held up through the spring and summer of 1985 as a messy diplomatic situation developed. On the one hand French authorities were reported to have intimated to Secretary of Defense Weinberger their stalled AWACS buy could be broken loose if the US made the right choice. The British for their part were trying to appeal to their prior record of purchases and commitments. Appeals to Reagan by British Defense Minister Heseltine through letters and via telephone calls were followed up by Prime Minister Thatcher's intervention with Regan on Plessey's behalf. Again Thatcher was pushing Britain's record of being a 'better' ally, citing the support of SDI in particular. One DoD source was quoted as saying he "had never seen such a power play" among our NATO allies. In the early fall the French system was selected.

The RITA system based MSE included the modified GTE AN/TTC-39 S-200 single shelter configured circuit switch (telepone exchange), the RITA radio access unit, the Canadian Marconi AN/GRC-103 or GR-083 line-of-sight radios, the GTE SB-3614 unit level switchboard, a digital group miltiplexer, the RITA mobile subscriber radios set, the Magnavox TA-954/M2 digital non-secure voice terminal, the Ericsson MF-15 down-the-hill microwave radio link, the Magnavox AN/GXC-78 digital facsimile and a RITA-based system control function.[25]

It is a hybrid system with GTE claiming that 65% of the total budgeted expenditure will be spent in the USA-generating in the order of 75000 US jobs.

A typical corps-level MSE deployment over a 37500 km square area could involve some 8100 subscribers of which about 6200 would be static and 1900 mobile.[26]

In the end, after weaving in and out various collaborative arrangements with the UK, the tortuous route ended up on the opposite shore of the channel. The US Army's tactical battle-field communications system is ultimately to be satisfied in the late 1980's through an arrangement along the lines of Mode #4 of industrial collaboration in lieu of the original #5 approach of the late 1960's. The history of the U.S. Army's tactical communication system serves as another reminder that the inter-allied thread has become an increasingly common element in our acquisition process, whether it be by design or happenstance.

1 Richard J. Trainor, Barriers to the Transfer of Military Systems Technology to the United States, 1976, p. 5.

2 W. J. Baird, "The Mallard Project - An Editorial," Signal, November, 1968, p. 9.

3 Trainor, op. cit., p. 5.

4 Ibid.

5 Fort Monmonth is the location of the Army Communication Agency, the Satellite Communication Agency, eight electronic communication laboratories and the associated procurement offices.

6 Major General Paul A. Feyereisen, USA, "Mallard - Its Direction and Control," Signal, November, 1968, p. 13.

7 Ibid., p. 17.

8 Ibid., p. 15.

9 Ibid., p. 13.

10 Trainor, op. cit., p. 6.

11 Comptroller General of the United States, Benefits and Drawbacks of U.S. Participation in Military Cooperative Research and Development Programs with Allied Countries, 1974, p. 38.

12 Trainor, op. cit., p. 6.

13 Ibid., p. 6.

14 Ibid.

15 Ibid., p. 7.

16 In a 1974 GAO study on Benefits and Drawbacks of U.S. Participation in Military Cooperative Research and Development Programs with Allied Countries, the reason for the U.S. having pulled out of the program, was stated to have been primarily this; one of interservice incompatibilities.

17 Trainor, op. cit., p. 7.

18 See Chapter 3.

19 Trainor, op, cit. pp. 7-8.

20 Ibid., p. 8.

21 Robert Raggett, "US Tri-Tac system set to get back on course, " Jane's Defence Weekly, 16 November 1985 p. 1067

22 Ibid.

23 Ibid.

24 Ibid.

25 Ibid.

26 Ibid.

E. NATO PHM

1. Introduction

The Patrol Hydrofoil Guided Missile (PHM) ships are vessels that combine both marine and aircraft technologies. They are high-performance, rapid reacting combat systems featuring foilborne top speeds in excess of 50 knots[1]. Six PHM's have been built to date for the U.S. Navy: the Pegasus (PHM-1), designed and built for the NATO program, and its five production series sister ships. Armament consists of: eight RGM-84A Harpoon anti-ship missiles; a 76 mm dual purpose gun for use against air, surface, and shore targets; two MK-34 chaff launchers for defense against anti-ship missiles[2]; and a MK-92 Fire Control System to tie them all together. Their technological sophistication makes them well suited for their mission—to operate offensively in coastal waters and narrow seas against major surface combatants and to conduct surveillance screening and special operations. Weighing only 243.5 metric tons and having length of 40 m, a PHM probably carries more weaponry than any other ship its size in the world.

> The PHM has amply demonstrated the anticipated technical performance and mission capability that was projected at the program outset. More than this, Pegasus has made many converts of those who could not earlier conceptualize the tremendous improvements that hydrofoils offer in operating capability or believe that such technology could be provided in an effective reliable system suitable for the Fleet.[3]

The PHM ship design resulted from NATO Navy Armanent Group activities between 1969 and 1972. Although the design is based on the much smaller (58.5 ton) USN/Boeing PGH-2 Tucumcari, the system does incorporate a substantial amount of European equipment.

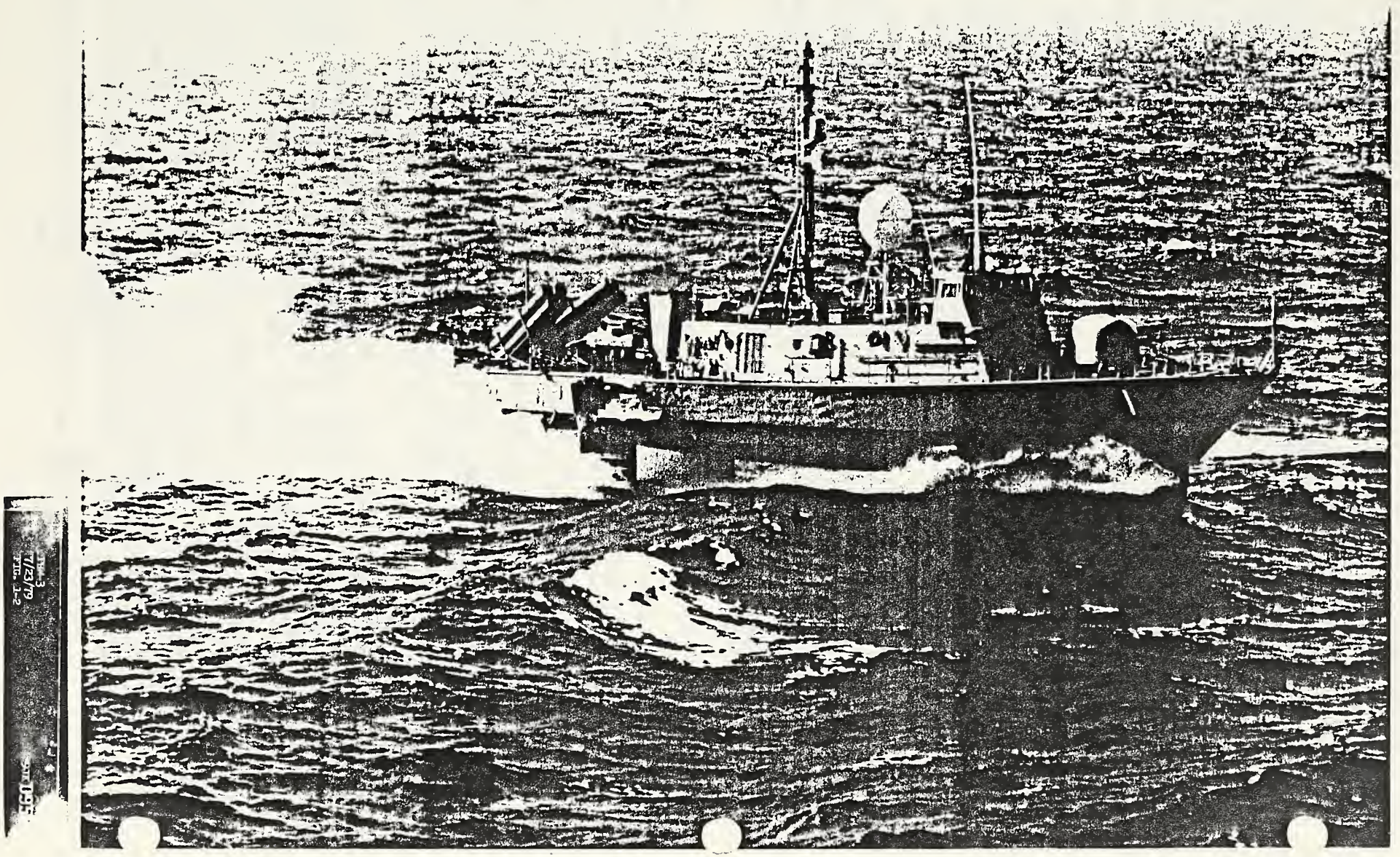
The genesis of this system represents one of the most superb marketing jobs ever accomplished through the NATO acquisition process. Unfortunately much like earlier NATO projects such as the Atlantic maritime patrol aircraft, the

NATO PHM program reflects the common problem of retaining the original participants in a joint design and development project (Modes #3, #5, and #8 of industrial collaboration) all the way through to production. Difficulty was experienced in maintaining the stability of the lead-ship design and development program. The U.S. is currently the only country to have undertaken production. Potential sales to, or production by, NATO members and other allied nations might yet develop over the next several years.

Additionally, the tergiversation within the U.S. government during the 1976-77 period, when the program was on the verge of cancellation conjures up visions of the UK's plight after the U.S. (i.e., McNamara) unilaterally cancelled the Skybolt air-to-ground missile project in 1962. The UK had previously cancelled its own unilateral effort with the understanding that the U.S. would continue Skybolt to fill both nations' requirements.

This aspect of the NATO PHM program brings out something that Europe's three medium powers (France, the FRG, and the UK) often emphasize, i.e., the vulnerability of such programs to unilateral cancellation,[4] with the dependent participants being left high and dry. There is also the loss for the other participants to be considered—the technological capabilities generated through the R & D effort. More specifically, a third and closely related consideration is U.S. technological dominance and the long term European effort to counter it. Therefore the Europeans have preferred 'joint' development over the U.S. 'interdependent' development preference. The DOD's former policy of supporting interdependent R & D involved the design and development work being unilaterally carried out within one nation (which was more often than not the U.S.), with the end product being available to all partners to the agreement for licensed production.[5] The NATO PHM project was much more in line with the

Source: Boeing PHM-1 Pegasus



U.S. approach than that of the Europeans. The interest of the DoD in Mode #8 of industrial collaboration reflects an attempt to bridge this gap through the 'Family of Weapons' concept.

2. The NATO Program is Launched

a. From Project Inception in 1969 to Signing of the MOU in 1972

A decision to proceed with a NATO PHM project was reached in October, 1971, by three nations working within the NATO Naval Armament Group's (NNAG) Project Group 6. After a year long study, the NNAG had selected the hydrofoil as the best of the competing platforms (Conventional Fast Patrol Boats (FPB's) and hovercraft) for a high-speed craft capable of surface attack, surveillance, and barrier operations to meet the growing Soviet surface-to-surface missile threat.

In November 1971 Boeing Marine Systems was awarded a sole-source letter contract by the U.S. Navy for feasibility and "trade-off" studies to determine the size and performance characteristics of a new class of submerged foil military hydrofoil. The ship was to meet the differing mission and combat system requirements of the navies of Italy, the Federal Republic of Germany (FRG), and the U.S.A.

The ship's primary mission was to augment the capability of the NATO main surface forces, particularly in the Mediterranean and Baltic seas. Although PHM employment was expected to vary according to national concepts of operations, general peacetime operations were to consist primarily of direct surveillance, either in support of task force operations or through shadowing of potential enemy forces, and area surveillance of straits and exits through restricted

NATO PHM Participating Nations

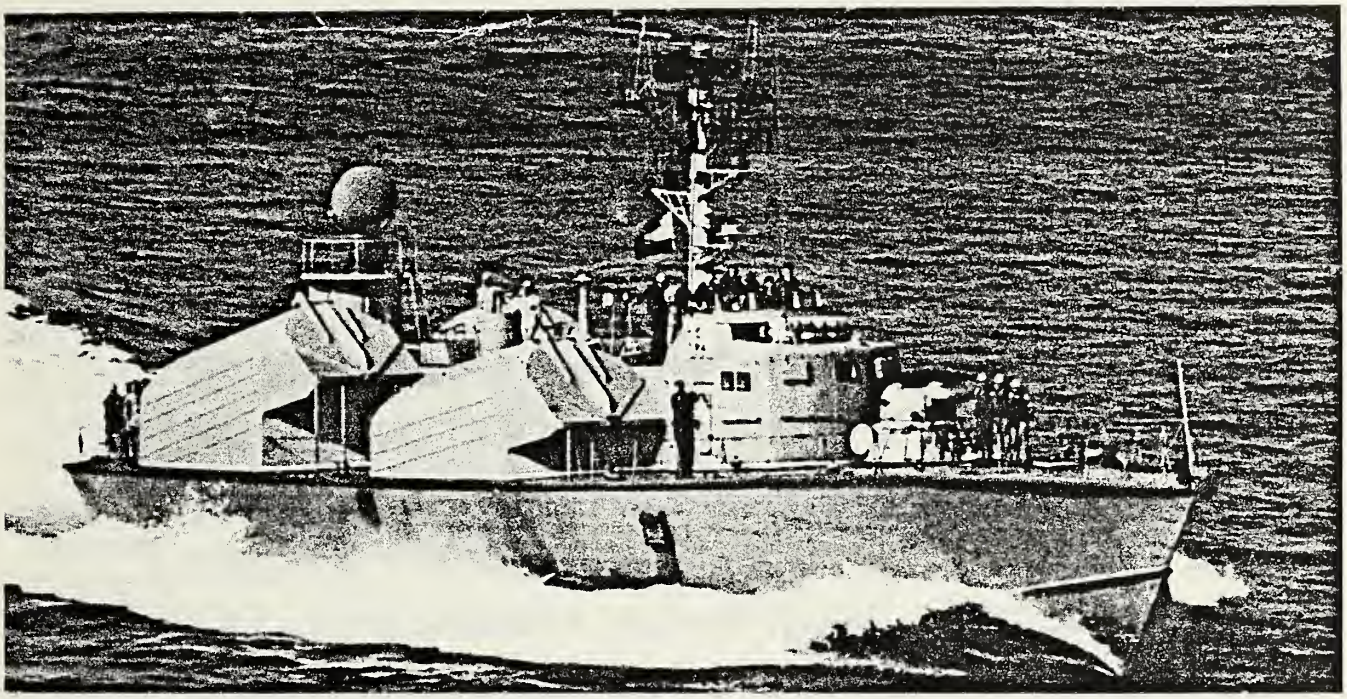


U.S.

Design, Development and Production

Design and Development





An Egyptian Osa-class missile boat underway in 1974. (Navy photo by E. V. Sneed.) The proliferation of such small but lethal craft has concerned naval analysts for years, but the advent of the Phalanx may remove the possibility of "cheap kills."

waters. Wartime operations were to detect and attack enemy surface ship forces.

Back in mid-1969 one of the NATO Military Commanders (NMC's), CINC South (the Armed Forces South Command in Naples, Italy) had presented to NATO's Conference of National Armament Directors (CNAD) a requirement for a large number of fast missile patrol boats.

The NATO requirement was generated subsequent to the October War and the sinking of an Israeli destroyer, the Elath, by Styx missiles launched from Egyptian patrol boats. It was initially a response to the threat posed by missile-armed fast patrol boats in the Mediterranean to larger allied combatants.[6]

The NATO Navy Armament Group's original sub-grouping working the problem, Special Working Group (SWG) 6 on small missile craft, had originally included a wider grouping of 11 nations. SWG 6 first met in the fall of 1969. In addition to Italy, the FRG, and the U.S., there had also been Canada, Denmark, France, the Netherlands, Norway, Portugal, Turkey and the UK. The British, French, Germans, and Canadians were originally promoting their own projects for adoption by several nations to form the basis of a NATO effort, but the U.S. sponsored project eventually prevailed for the reduced grouping of nations.

The threat was soon expanded to include major combatants as well as fast patrol craft, with the result that the entire Allied Command Europe was considered as the threatened area. Further deliberations were deemed necessary and, during the early months of 1970, NATO Exploratory Group Two was

established to study the concept of a Common Fast Patrol Craft (Guided Missile). This group completed its deliberations in September 1970 and concluded that the submerged foil, hydrofoil craft, basically of the 140-ton size proposed by the United States Navy, was the craft most suitable for meeting the NATO mission requirement. The NATO Naval Armaments Group received this report the following month, accepted the recommendations contained therein, and approved the establishment of NATO Project Group 6 to conduct the planning stages of the program and the initial determination of the ship characteristics.[7]

Under the sponsorship and chairmanship of the United States, Project Group 6 held its first meeting in November 1970 at NATO headquarters in Brussels, Belgium and reached general agreement on the management approach to be pursued. It was established that early phases of the program would consist of several "open ended" meetings with participation by all interested countries. Through June 1971, a series of four "open" meetings were held with representatives from 10 nations. During this period, United States' representatives presented further hydrofoil baseline design and cost estimates, and ultimately a draft outline for a Memorandum of Understanding (MOU). The design data provided for the operational performance agreed upon by Exploratory Group Two and incorporated previously expressed national requirements. In addition, as program sponsor, the United States, committed itself at the June, 1971 Project Group 6 meeting to the building of two PHM lead ships if a design satisfactory to at least one other NATO nation could be achieved.[8]

At the conclusion of the June 1971 meeting of NATO Project Group 6 in London, it was mutually agreed that active participants of subsequent meetings would be limited to those nations who had formally declared their intent to proceed

with the cooperative hydrofoil project, and subject to conclusion of an agreed MOU, to formally enter the program as an "engaged" nation and commit resources thereto. Letters of intent were signed and delivered to the U.S. at the July 1971, NATO Project Group 6 meeting by the governments of Canada, Italy, the FRG, and the UK.[9]

All the others had to drop out of PG-6 following agreement on the joint funding of a feasibility study. The nations which originally opted to stay on as observers (i.e.,non-voting members) of Project Group 6[10] were joined later in the year by Canada, and then the UK, both of which backed away from their initial commitments. None of the observer nations ever elected to actually join.

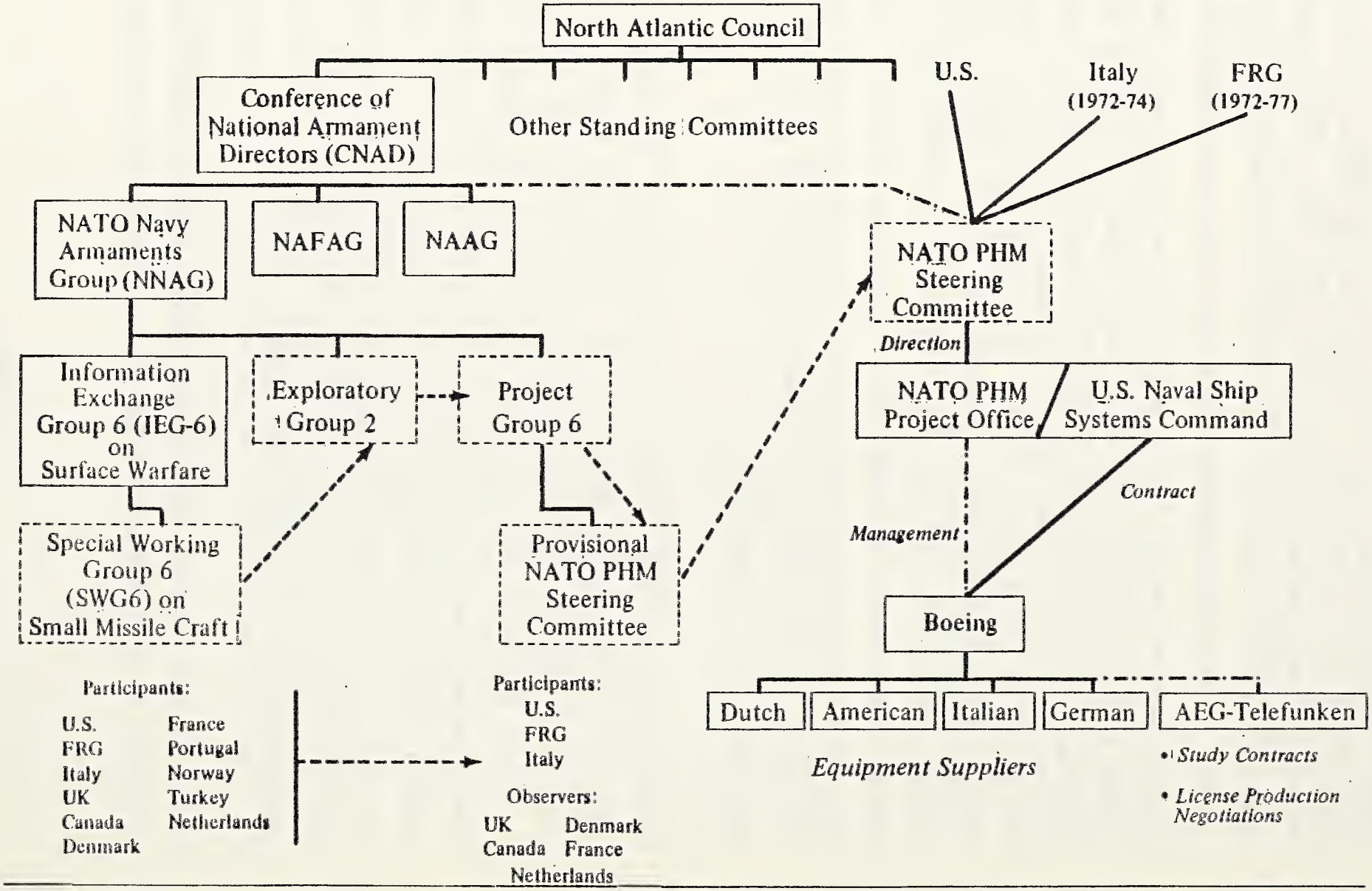
In October 1971, the United States announced its intentions of awarding the lead ship design and construction contract to Boeing, and that the initial effort under the contract would be for additional feasibility design studies. The objective of these studies was to obtain clear agreement on a specific common ship design which would satisfy all engaged nations' requirements. Further, due to the advance in program schedule without having yet obtained a satisfactory MOU, the United States indicated it would proceed at its own expense with the NATO design, share the results of these studies with all engaged nations (with costs to be reimbursed only by those engaged nations which later signed the Memorandum of Understanding), and to conduct all aspects of the design development, contract definitization and management in cooperation with the engaged nations. In November 1971, the United States thus initiated Phase 1 of the lead ship design and construction stage program with the award of a letter contract to Boeing.

Commencing with the October 1971 meeting, it was intended that Project Group 6 would have three principal tasks: to provide overall guidance, to establish an organization to manage the acquisition process, and to define and develop a technically feasible, economically viable NATO Standard PHM ship system.[11] Although a Steering Committee was only slated to assume the responsibility for project direction from NATO Project Group 6 once the MOU had been formally signed, with the signing of the second round of letters of intent by only the governments of Italy and the Federal Republic of Germany in the fall 1971, it was decided that a provisional Steering Committee be formed by the three engaged nations as an autonomous sub-grouping of NATO PG-6 to guide the project, exercise executive control over the provisional NATO Project Office, and be responsible for the implementation of the design stage until the MOU was signed (the prospective date for which had now slipped to early 1972). The first provisional NATO Steering Committee meeting took place in Washington, D.C. in January 1972.

Project Group 6 continued to meet into the fall of 1972, but soley as a vehicle for keeping Canada, Denmark, the UK, and the other observer nations informed so that they could later join the project if they eventually elected to do so. By mid-1972 PG-6 observers included only Canada, Denmark, France, The Netherlands, and the United Kingdom. Although only three governments had decided to actively participate, future project membership was still not restricted. In the spirit of NATO cooperation, an additional government could join the project at any time following consultation among, and joint negotiation with, the original three committed nations.

During early 1972 efforts were devoted to completion of the Feasibility Design (completed in March 1972) and completion of a draft PHM MOU suitable for

NATO Patrol Hydrofoil Missile (PHM) Project



ratification. It became clear early in the year that signing of the MOU and commitment of funds would not occur until some appreciable time after draft MOU completion; hence, additional letters of intent, fully acknowledging the specific design and cost schedule obligations being entered into were requested by the United States. These were provided by the governments of Italy and Federal Republic of Germany in April and May 1972, respectively.

In November 1972 the MOU for the design and development of two lead-ships was belatedly signed.

b. Distribution of the Technical Data and Work Package among the Three Nations

Having completed the feasibility study, Boeing[12] was awarded the PHM-1 and PHM-2 design and construction contract in February 1973 for $42 million. The contract was awarded by the Naval Sea Systems Command, Washington, D.C. on behalf of the three participating navies. These were to be USN ships, therefore Italy and the FRG shared only in the payment of non-recurring costs. At this time the U.S. Navy planned a follow-on order of 28 additional hydrofoil gunboats if evaluation trials proved successful, while the FRG was to procure 10 PHM's, primarily through license production, and Italy was to procure four for its Navy, either off the U.S. line or through license production.

The FRG and Italy were to receive the technical data package (TDP) for the PHM developed in the U.S. to meet their combined requirements. Total cost for the lead-ship design and construction phase was eventually to come to $128.5 million. In addition to the $42 million dollar award to Boeing (later escalated to $45 million) the balance of the $128.5 million in expenditures went to costs of running the NATO Patrol Hydrofoil Project Office (NPHPO) in

Washngton, D.C., Government Furnished Equipment (GFE) and tooling, technical support, and so forth.

National contributions for the funding of this phase through mid-1977 came to:

U.S.	$85 million	
FRG	$30 million	(withdrew mid-1977)
Italy	$13.5 million	(withdrew early 1974)

Italy and the FRG each received, royalty and restriction free, PHM lead-ship technical data packages, complete as of the time of their respective withdrawals. Neither country, though, received the series production TDP.

Though Boeing received the prime contract, European industry provided a significant percentage of the subsystem of the PHM.

3. Precursors of the PHM

a. Early Boeing IR&D Projects

Boeing's hydrofoil R&D effort dated back to August, 1959. This included an investment by the Company of an estimated $100 million in R&D by the time the NATO project was launched, as well as another $50 million since.

During that period the Company led the industry in moving the submerged foil concept from experimental demonstrations on Lake Washington and Puget Sound to operational systems deployed by the U.S, the Italian and the Royal Navy in the South China Sea, the Mediterranean Sea, the North Sea, and the Caribbean Sea. In the course of this work, the Company played a significant role in every major U.S. Navy hydrofoil ship program, and has been the leader in hydrofoil waterjet propulsion.

Research began in 1959 at Boeing, and in 1960 a hydroplane test craft with a hull made principally of mahogany plywood was built. Designated the Hydrodynamic Test System (HTS) and nicknamed Aqua-Jet, the lobster-shaped craft had two prows, each with a cockpit and instrument compartment. The open center was used like a wind tunnel for preliminary hydrodynamic testing. In addition to foils, the craft was used for antisubmarine warfare testing.

Boeing developed a second company-sponsored R&D hydrofoil in 1962, Little Squirt. The three-ton wooden hulled boat was built to prove the feasibility of waterjet propulsion concepts now used on all Boeing designed hydrofoils. The craft's foil system was arranged in a conventional configuration,

primarily to accommodate the installation of a single waterjet pump. Although the major contribution of Little Squirt has been in the area of waterjet propulsion, during her years of service, she provided a number of important answers with regard to hydrodynamics, structure and foilborne control. For example, Little Squirt demonstrated the disadvantages of the "conventional" foil arrangement under conditions of forward foil broach. In this condition, the simultaneous requirements for roll control and foil depth control were found to be impossible to satisfy with a ventilated forward foil, and violent pitch-roll-yaw motions characteristically resulted. The surface-piercing trailing edge rudder on the aft strut was also shown to provide unreliable directional control because of ventilation and lack of bow-down control area. This experience contributed to the selection of the steerable forward strut for directional control of Boeing hydrofoils.

Little Squirt was also used as a test bed for the development of a number of systems, including the automatic control system and the trailing-edge concept as a method of hydrodynamic control. The acoustic altimeter, mounted on the bow, and flap controls have been used on all subsequent Boeing hydrofoils. Little Squirt also demonstrated a 50-knot capability for hydrofoils.

b. The USN/Boeing PCH-1

In 1959 the US Navy received Congressional Approval to include in its 1960 Shipbuilding Program a hydrofoil craft suitable for carrying out anti-submarine patrols. This was to be the U.S. Navy's first hydrofoil ship with a fully-submerged foil.

Source: Boeing PCH-1 High Point

From among the seven firms bidding,[13] a contract was awarded to the Boeing Company in June 1960 for construction of a patrol craft hydrofoil designated the PCH-1. The vessle was subsequently named High Point. Its design, by the U.S. Navy Bureau of Ships, was based on the successful demonstration of a fully submerged, automatically controlled foil of a small experimental craft built in 1956, named Sea Legs. The Sea Legs was scaled up to the PCH-1 design by the original naval architect, Gibbs & Cox. PCH-1 was detail designed and constructed by Boeing at facilities leased from the J.M. Martinough Shipbuilding Corporation in Tacoma, Washington. The ship was delivered to the USN in 1963.

The High Point is 115 feet long, has a beam of 31 ft and displaces 110 tons. The power plant consists of two Rolls-Royce Proteus marine gas turbines, each delivering 3,000 shp. In the "flying" mode, speeds up to 60 knots have been achieved. The vessel has accommodations for a crew of 13 and currently carries, for experimental purposes, sonar and radar equipment.

An extensive test program with this vessel furnished the first experience with a submerged foil system in all speed regimes. As expected, many technical difficulties, especially in the hydrodynamic field, were encountered.

After the ship passed acceptance trials and was delivered to the U.S. Navy in September 1963, it went into a trials program. As first configured, High Point experienced directional stability and control problems both in calm water and in rough water. These problems included directional divergences and erratic response to the helm.

The principal lessons that were learned with regard to directional problems were:

- Exclusive use of banked turns is mandatory;
- Yaw rate feedback to the rudder is mandatory;
- Good directional stability under adverse conditions of relative strut immersion in waves is mandatory, and;
- A fully steerable forward strut is mandatory.

In the early rough water trials, the High Point also experienced pitch-heave motion problems. Computer studies revealed that while a wide range of possibilities exist for satisfactory automatic control under calm water conditions, successful operation in heavy seas can only be accomplished with very specialized control techniques. It was found that the controlled dynamic response of the ship must be carefully tailored with respect to wave encounter frequency if the full seaway potential of the ship is to be realized. It was also found that the occurrences of foil broaching could be minimized by accepting wave cresting of the hull in seas of wave height in excess of forward strut length. The application of these studies has subsequently permitted High point to operate successfully in significant waves in excess of 4 meters, well above her specified design requirement for operation in 3 meter significant waves.

The ship completed a series of R&D trials in 1971 prior to layup for major modification in accord with design changes conceived by Boeing. This major modification, completed in 1973, incorporated many of the technology advances proven by a later USN/Boeing hydrofoil, the PGH-2 Tucumcari. For example, the modified PCH-1 was outfitted with a fully steerable forward strut, dihedral

after foils and a new automatic control system of Boeing design. In addition, some of the hydrodynamic deficiencies of the propulsion pod arrangement were corrected by a reconfiguration of the aft foil/strut/pod system.
Chief among the problems encountered in the hydrodynamic field was cavitation. Cavitation can occur in any object moving at high speed through the water. Vapor cavities form on the upper side of the foil. These are not stable but oscillate rapidly in such a manner that water particles impinge with considerable force on the foil surface, quickly eroding the toughest metal. The seriousness of the cavitation problem may be judged by the fact that the original propellers of the High Point had a life expectancy of only two hours at 45 knots.[14]

The High Point, however, was built to study just such phenomena and a variety of newly designed propellers and erosion-resistant materials to cover the foils and struts were tried. Although it was found that, through careful design, many harmful cavitation-forming conditions can be avoided, they are difficult to eliminate completely. Therefore, the water-jet propulsion approach, a design

which circumvents the propeller-cavitation problem entirely, has generally prevailed over the propeller-driven ship for military purposes and was adopted for all subsequent Boeing designed hydrofoils.[15]

The PCH-1 is currently based in Bremerton, Washington where it continues to serve as a test platform.

c. The USN/Boeing FRESH I

In June 1961, the year following the PCH contract award, Boeing was awarded a second USN contract for the design and construction of another experimental hydrofoil, the Foil Research, Experimental, Supercavitating Hydrofoil (FRESH I). The FRESH I was to serve as a research platform for experimenting with foil and control systems. The FRESH I, launched in February 1963, was to have had an ultimate speed capability of 100 knots and a required demonstrated capability of 80 knots. Although it never attained its speed objective of 100 knots, it still holds the hydrofoil speed record of 84 knots.

The FRESH I's greatest contribution was in the field of stability and control, where it demonstrated the importance of directional and roll stability. It was tested in two configurations - one foil forward, two foils aft (canard) and two foils forward, one aft (conventional airplane). Propulsion was by a single-aircraft turbofan. Its unique design allowed large variations in foil location

and arrangement and the testing of a wide variety of foil configurations and automatic controls.

The craft was fully instrumented and outfitted with an onboard data acquisition system. The craft repeatedly demonstrated foilborne speed in excess of 80 knots on a foil system utilizing base-vented cambered parabolic sections arranged both in a canard configuration and in a conventional configuration. At these speeds, the highest yet attained by any hydrofoil craft, the foil system was found to be structurally sound and free of hydroelastic problems. As predicted

by foil model tests, the only cavitation experienced was stable non-erosive leading-edge cavitation.

During final acceptance trails for the U.S. Navy on 18 July 1963; the craft broached as a result of being mistrimmed, went into a divergent turn and overturned. Craft damage was limited to minor non-structural distortion and salt water immersion effects. The craft subsequently was refurbished without basic changes to the configuration, passed trials and was accepted by the Navy in October 1964. As a result of this accident, it was learned that hydrofoils must provide good directional stability under all reasonable conditions of flying height and boat trim. This is directly reflected in the foil arrangement and control system configuration of both Tucumcari and the PHM, which provide good directional stability in the broached condition and directional control in bow-down attitudes. The directional stability is achieved through after-foil dihedral, and the dependable directional control is achieved with the fully steerable forward strut.

d. AGEH

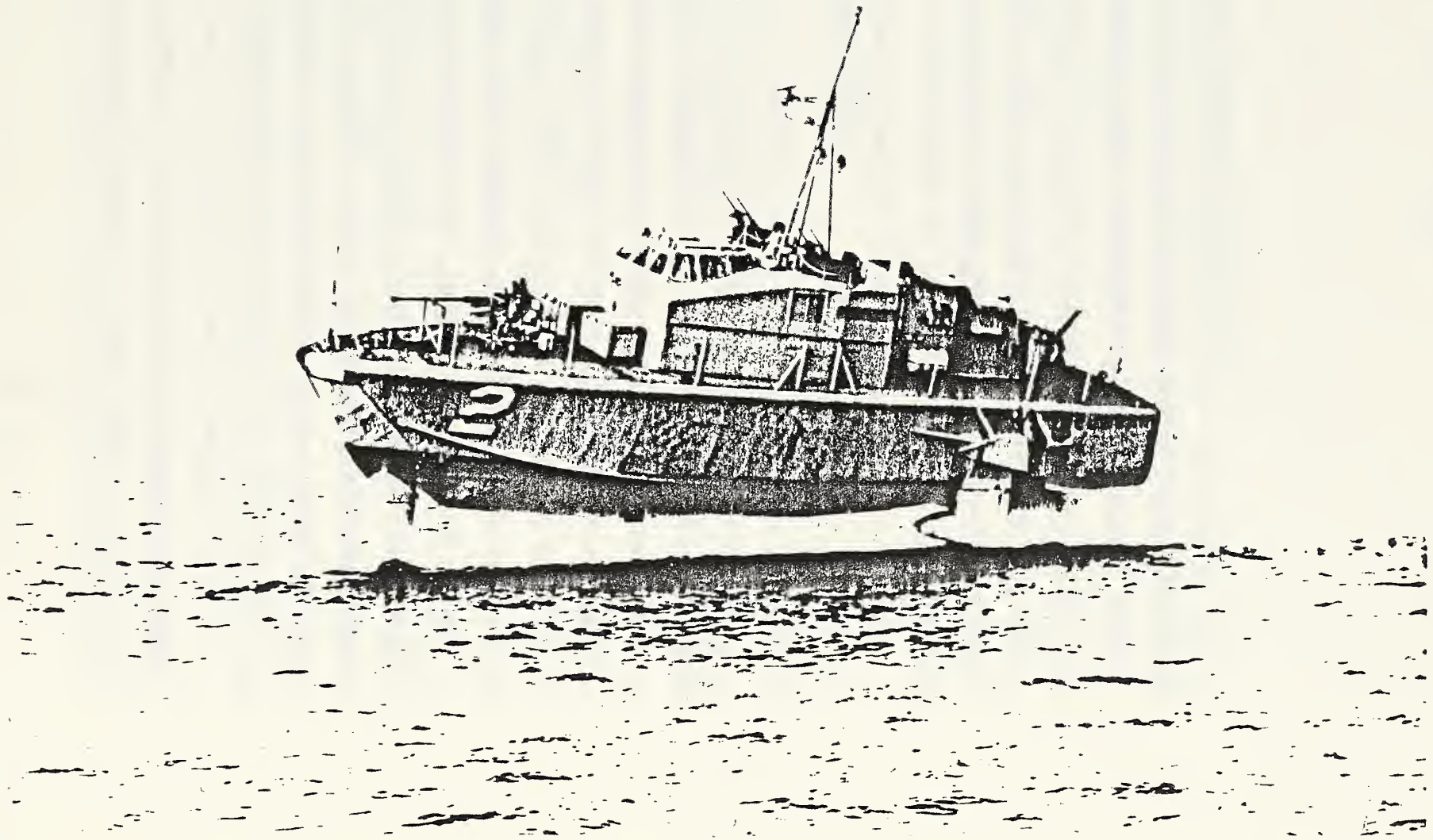
The technology developed with the FRESH I was originally scheduled for incorporation in the second phase of yet a third USN hydrofoil project, the 312 ton AGEH Plainview designed by Grumman and built by Lockheed Shipbuilding and Construction Company in Seattle, Washington. The AGEH had a maximum speed of 50 knots with a provision for conversion to 100 knots through incorporation of FRESH I developments. Phase 2 of AGEH however, was cancelled.

The 312 ton Plainview is currently the world's largest hydrofoil ship. The Boeing Company has participated in the program since 1966, when the U.S. Navy awarded the first of a series of contracts for control simulation studies. These studies led to the identification and correction of a number of ship control problems and have been a basis for automatic control system redesign work by Boeing under later contracts. Boeing provided the contractor support to the U.S. Navy for the maintenance, modification and operation of the ship and played an active role in overhaul work. Boeing experience with this 312 ton ship provided valuable design knowledge for larger size hydrofoils. For example, the serious hydraulic system problems of the AGEH can be attributed to the developmental nature of the large hydraulic system required for foil-borne control of variable incidence foils. This problem was avoided on the PHM by a reduced hydraulic requirement due to the use of flap control, allowing the use of proven available commercial aircraft hydraulic components.

e. The USN/Boeing PGH-2 Tucumcari

In 1966, the USN proceeded with the next phase of its hydrofoil program with the award of two fixed price contracts for the design, construction and trials of 58-1/2 ton (60 ton when fueled up) experimental hydrofoil gunboats for test and evaluation by the U.S. Navy. One contract went to Grumman for the vessel designated PGH-1 Flagstaff, and the other to Boeing for the PGH-2 Tucumcari. The two craft were completed in 1967 and delivered to the USN in 1968, whereupon the each transitted open ocean to San Diego to undergo operational evaluation by the Naval Test and Evaluation Forces Pacific.

Source: Boeing PGH-2 Tucumcari



The two hydrofoil gunboats were to meet performance specifications presented in a Circular of Requirements, each contractor being given complete freedom to design the best vehicle to meet the following foilborne performance requirements:

- Maximum continuous speed in calm seas — 48 knots
- Required turn radius in calm seas at 48 knots — 213 meters[16]
- Calm water range — classified
- Helmsman able to hold heading in 2 meter significant waves — ±5 degrees
- Maximum vertical accelerations in 2 meter significant waves (avg. 1/3 highest) — 0.25 g's
- Transit 400 nautical miles in rough water at average speed of 40 knots.[17]

Both craft underwent test and evaluation, but no production award ever followed due to Viet Nam War related operational priorities.

Though the U.S. Navy only belatedly completed its formal source selection process, following deployment to Vietnam[18] and Western Europe, the PGH-2 was evaluated in the fall of 1971 as the superior design. With the completion of DSARC I, the U.S. Navy fell in line with the Italian and German navies, and thus cleared the way for the NATO project (the two allied navies having each previously selected the PGH-2 as the basis for derivatives and/or a follow-on system).

The PGH-2 incorporated design features introduced as a result of the Navy's experience with High Point, key among these being:

- steerable strut and single-foil forward main foils aft (canard);

- anhedral foil configuration;[19]
- gas turbine-driven water-jet propulsion;
- and an electronic/hydraulic control/actuation system.

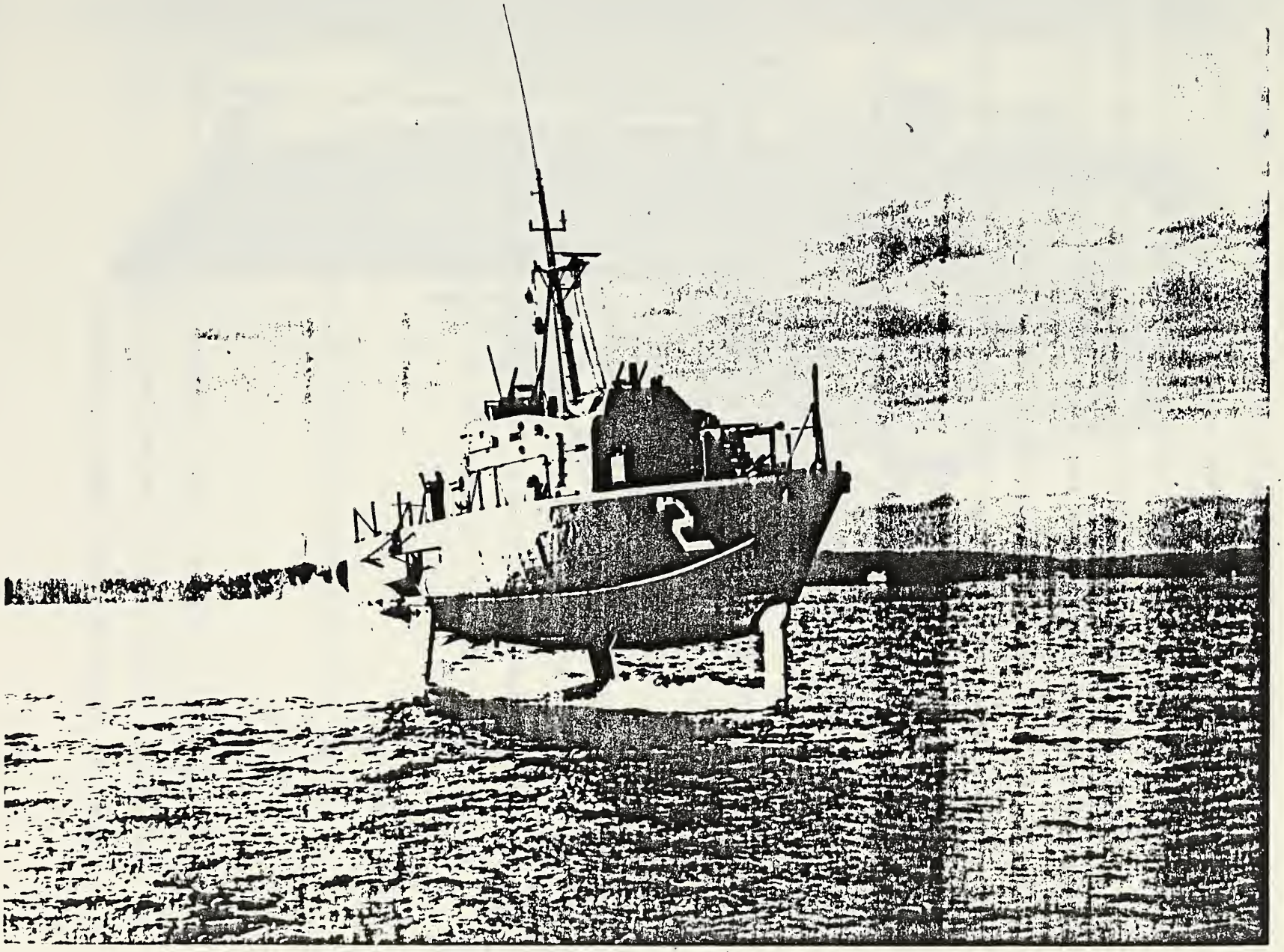
The Tucumcari operated in seas up to seastate 6 which was well beyond its design requirement. Moreover, the Tucumcari demonstrated that a properly designed hydrofoil ship has maneuver capabilities far beyond those of conventional ships. These capabilities are reflected not only in the ability to achieve high turn rates in all sea conditions, but also in terms of unusually prompt response to helm commands.

The PGH-2 came out ahead of the PGH-1 in the following areas:

- reliability (the PGH-1 was only marginally seaworthy);
- foil arrangements;
- control system (e.g.,the PGH-2 was a much simpler system to operate, all ship members could handle it, even the cook).

Furthermore the Tucumcari was on schedule while substantially exceeding performance requirements. The Flagstaff was some eight months behind schedule and unable to meet its technical requirements (e.g. at 64 tons it was 15% overweight, whereas the Tucumcari met the spec exactly at 58.5 tons).

As for the critical (and still somewhat controversial) area of choice of propulsion systems, Grumman had chosen a gear-driven supercavitating propeller system for the PGH-1, and Boeing had selected a water-jet propulsion system for its



Source: Boeing PGH-2 Tucumcari

PGH-2. The water jet system proved itself to be the better system, but there were a number of drawbacks, and some quarters of the U.S.N. had trouble reconciling themselves. The water-jet avoided the supercavitation problem altogether, had fewer mechanical problems, was less costly to manufacture, and had a substantially better record in the area of reliability and maintainability.[20] The drawbacks of the water-jet propulsion approach, in comparison with that of the propeller, were that it consumed 15%-17% more fuel and accelerated more slowly.

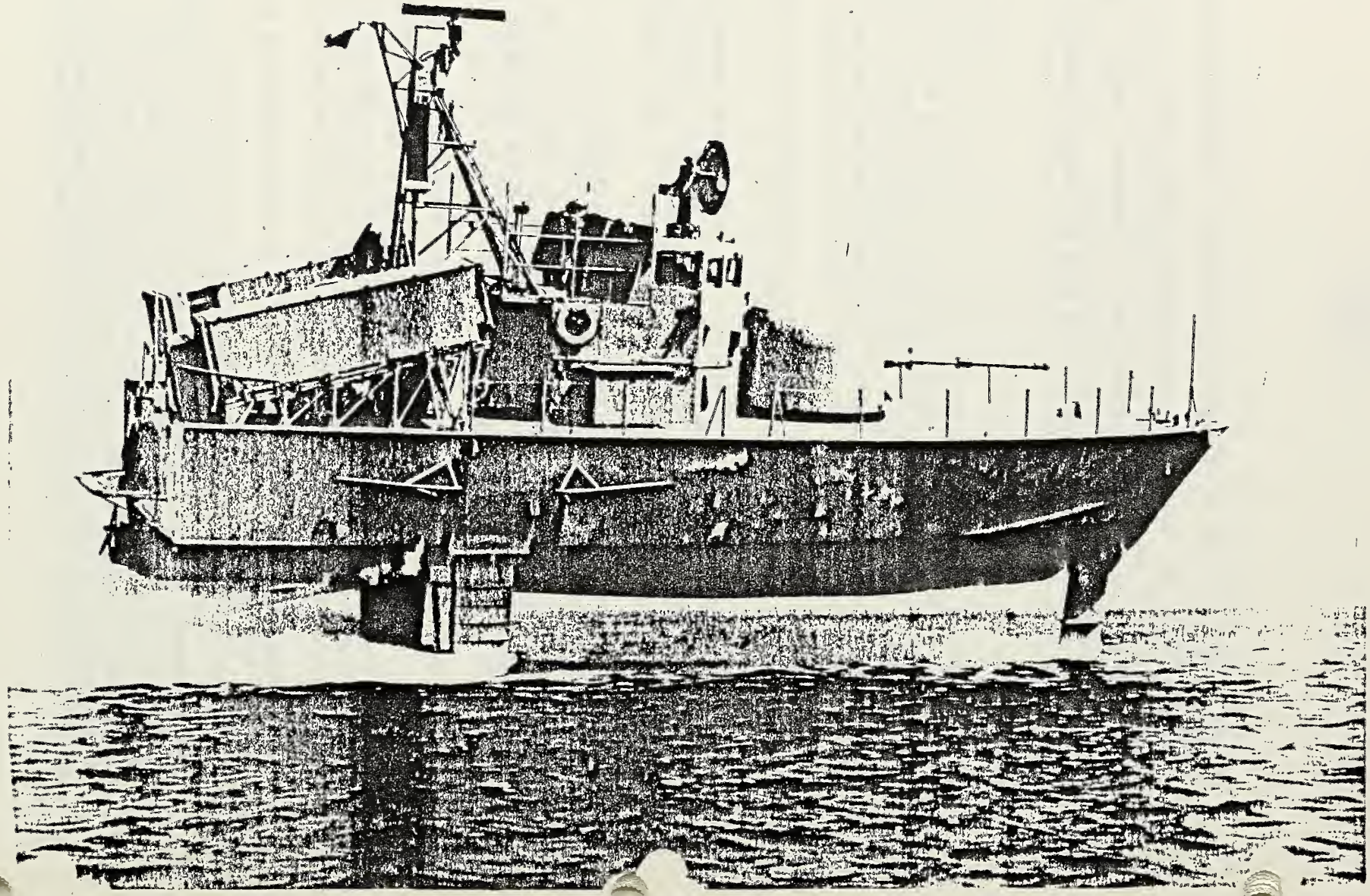
f. The Boeing-Italian P-420 Spaviero and the P-421 Nibbio Class of Military Hydrofoils: Italian Navy's Derivative of the Tucumcari

(1.) Boeing Establishes Alinavi in Italy in 1968 and is Awarded the P-420 Spaviero Contract in 1969. In the meantime, unable to obtain USN interest in a PGH-2 production run, Boeing had decided to look elsewhere for a customer and partners to justify further capital investment. This they had found in Italy. In 1968 Boeing established a joint venture in Italy, Alinavi, to market, develop and produce a derivative of its PGH-2 Tucumcari under license from Boeing. Alinavi ownership was originally distributed as follows:

Boeing	60%
Istituto per la Ricostruzione Industriale (IRI)	30%
Rodriquez	10%

IRI is a holding company for Italian government owned firms, while Rodriquez is a privately owned Italian firm which had produced many surface-piercing commercial hydrofoils under license to Supramar.

Source: Boeing P-420 Spaviero



An engineering development contract was awarded to Alinavi by the Italian government in 1969, one which led to the construction of a lead-ship based on the PGH-2 Tucumcari, the P-420 Spaviero (the Seahawk, or more commonly known in the U.S. as the Swordfish) military hydrofoil. The ship was built and tested at the OTO Melara facility in La Spezia, Italy. A Boeing team headed up by Harold Turner and fluctuating between 3 and 5 people was located at La Spezia to provide technical assistance on ship design. The Spaviero was launched in May 1973.

(2.) A Comparison of the Spaviero with the Tucumcari. The Italian Navy Spaviero is basically the same ship as the U.S.N's Tucumcari, slightly modified for a much more sophisticated weapons suit. More or less in line with Boeing's original share of Alinavi ownership, there is about a 60% commonality between the Tucumcari and its Alinavi derivative, the Spaviero.

The Spaviero's foil is identical to that of the Tucumcari, and the hull, struts and autopilot are only slightly modified. Even though its hull is only a little wider than that of the Tucumcari, it has a completely different superstructure. The Spaviero has a range of 450 nautical miles at its maximum speed of 50 knots.

The major difference between the 58.5 ton Tucumcari and the 62-ton Spaviero, stems from the latter's armaments. The Tucumcari, as a one of a kind prototype built to evaluate major advances in ship design, was only lightly armed. It was equipped with one manually controlled 40 mm gun forward, two 50 caliber

Spaviero derivative was designed, utilizing a proven ship design, to serve as a replacement for the Italian Navy's conventional fast patrol boats (FPBs). As such, it had to mount armament typical of the most modern FPBs — i.e. an automatic dual-purpose gun forward, a fire control system, and surface-to-surface missiles aft.

Early studies considered several different gun-missile combinations, with a design-goal weight of 11.3 tons for the weapons suit, and a ship displacement of 59.5 tons. The Italian Navy's final choice specified an OTO Melara 76 mm Compact gun forward, the same gun later chosen for the NATO PHM. The gun was controlled by an Elettronica San Giorgio (ELSAG) NA 10 mod 1 fire control system. The anti-ship missile chosen for the Spaviero was Otomat.[21]

This final selection resulted in a weapons suit weight of 14.3 tons, 3 tons over the 11.3 tons originally specified. It was this that necessitated a total redesign of the superstructure and a widening of the hull by 3.5 feet.[22]

Other less apparent, but significant, differences between the two craft are the Spaviero's lighter 400 Hz electrical power system versus Tucumcari's 60 Hz system, and the more efficient diesel-powered steerable-retractable propeller outdrive for hullborne propulsion (as compared with Tucumcari's waterjet system serving for both hull-borne and foil-borne propulsion.) The main pump and the SEPA stabilization system are also of Italian origin. The Spaviero's Rolls Royce Proteus gas turbine engine has several hundred shp more than that of the Tucumcari.[23]

(3.) Performance Testing. The year following the Spaviero's launching in May 1973 was spent in final outfitting, normal first-of-class debugging, making modifications and improvements shown desirable during testing, and undergoing customer acceptance trials.

Performance testing conclusively demonstrated the Spaviero's outstanding speed and good range capabilities, even with relatively heavy armament. In the process, Boeing-Alinavi hydrofoil technology was shown to be mature, as seen by the close correlation of predicted and actual performance, even after a significant change in armament following contract signature. Finally, actual performance revealed good growth potential for the craft.[24]

(4.) Operational and Maintenance Savings in Comparison with Conventional FPB's. The economics of operating and maintaining Spaviero and the P-421 class of hydrofoil are especially impressive, both in comparison with conventional fast attack craft and in consideration of the technological advance represented by the system.

Generally, in conventional FPB combat ships, the manning costs alone can add up to as much as half the ship's total "life cost". The Spaviero on the other hand, with its 10-man crew, requires only 25 to 40 percent of the crew (25 to 40 men) typically associated with conventional FPBs carrying similar armament. Manning cost are thus drastically reduced.

Another area of potentially significant savings is in fuel. The Spaviero has only one Proteus gas turbine engine, developing a maximum of 4500 shp. This

gives the craft a range of 360 nautical miles at 45 knots, during which time about 8 tons of fuel are burned. A conventional FPB, such as the Combattante II, has three times the installed horsepower, and will burn three times the fuel (approximately 25 tons) to travel the same distance, and at a speed of only 30 knots.[25]

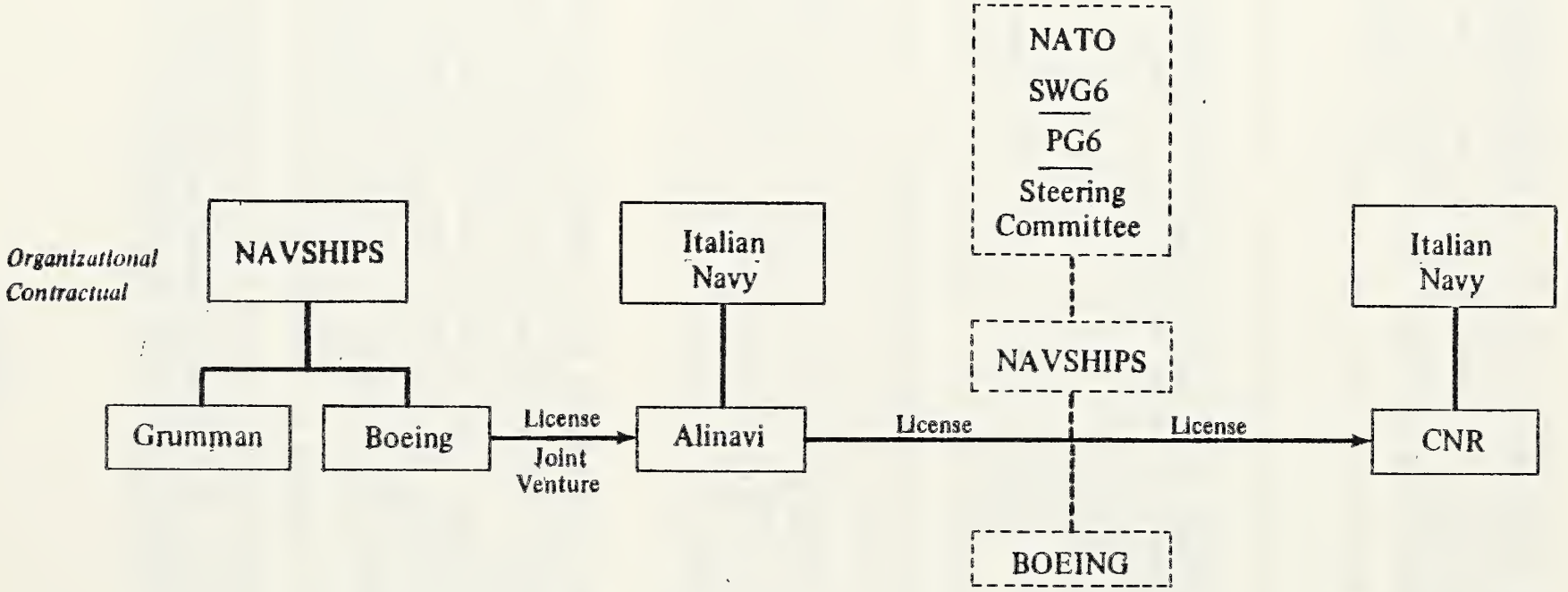
Maintenance is best considered by discussing those major components of a hydrofoil which differ significantly from the corresponding components of a conventional craft: i.e., the structure, including foils and struts; the flight control system; and the foilborne propulsion system. Other components of the hydrofoil are for the most part similar or identical to the corresponding components of conventional craft, and therefore maintenance is similar.[26]

The foils and struts are made of corrosion-resistant stainless steel. The only maintenance consists of periodic replacement of flap bearings and, if the client so desires, repainting of the struts for aesthetic reasons.

The flight control system comprises two basic elements: the electronic portion represented by the automatic control system; and the hydraulic system with associated mechanical linkages. The automatic control system consists of hermetically sealed solid-state components and, as such, requires no routine maintenance. The hydraulic system consists of 3,000 psi components, many of which have been proven in hundreds of thousands of hours of jet aircraft flight, and which have been designed specifically to require low maintenance and provide high reliability (after more than 30 months operation, the Tucumcari was reported to have never experienced a flight malfunction).[27]

The Italian Military Requirement

1969-1983



The foilborne water-jet propulsion system consists of inlets, ducting, a Rolls-Royce Proteus gas turbine engine driving a large pump through a flexible coupling, and nozzles. The maintenance requirements of the Proteus turbine (utilized on both the PCH-1 High Point and the PGH-2 Tucumcari) are well known due to its wide adoption by many of the world's navies, and need not be mentioned here. The pump for its part is made up of exceptionally maintenance-free components.[28]

(5.) Series Production in Italy of the P-421 Nibbio Class Under License to Boeing. In November 1974 Boeing opted out of its equity participation role in Alinavi, becoming simply a licensor. This was necessary for Alinavi to qualify for the award of a follow-on contract from the Italian government. Italy's new Ten-Year Military Program Law had been written so as to require that any shipyard receiving a contract be fully Italian owned. Boeing and Rodriquez sold their shares to the Italian government owned Cantieri Navali Riuniti of the Fincantieri Group (which also assumed those of I.R.I.) along with the right to build and sell the P-420 class of hydrofoil world- wide, while retaining the rights to a royalty on all vessels sold. Through a licensing agreement (Mode #1 of industrial collaboration) Boeing could still assure itself a return on investment while avoiding the risk inherent in equity participation. In 1980 Alinavi ceased to exist, being fully absorbed by Cantieri Navali Riuniti (CNR).

Having dropped out of the NATO program in late 1974 for what was to have been the PGH-2 follow-on vessel (and one derived from a military requirement generated by NATO's AFSouth Command in Naples, Italy) the Italian government

committed itself instead, in 1977, to series production of the smaller military hydrofoil. CNR is now building six additional P-421 class hydrofoils for the Italian Navy in La Spezia. One was to be launched in 1979 and the remaining 5 in 1980 and 1981, at intervals of four months. The first unit for series production, the P-421 Nibbio, began sea trials in late 1980. As of the spring of 1983 five of the ships had been launched with the sixth one scheduled for later in the year. Foreign sales had yet to materialize, but CNR was optimistic to its chances of closing with several prospective customers in the near future.

Boeing received its first royalty payment from CNR in December 1980. The sum, paid in Italian Lira came to around $600,000. The royalty to Boeing Marine Systems for the first three series production ships will be 5.2% of the ship sales price, jumping to 7.0% for all subsequent ships produced. For all licensed parts production the royalty will be 5.2%. As would be expected in any license production program, CNR is still procuring from Boeing Marine Systems under an Umbrella Purchasing Agreement, a limited amount of hardware and technical assistance.

4. Boeing's European Technical Marketing Activities for a PGH-2 Follow-on System: September 1969 to November 1971

Meanwhile, following shortly upon the successful landing of the contract from the Italian Navy for construction in Italy of a Tucumcari derivative, the P-420 Spaviero military hydrofoil, Boeing began to weave a more ambitious web of interrelationships that would lead to a NATO PHM program, for a Tucumcari follow-on ship.

a. European Marketing Activity from September 1969 to September 1970

In September 1969, the Manager of the Boeing Marine Systems (BMS) Organization within the Boeing Aerospace Company, Mr. A. M. Gonnella, was in Brussels to support a presentation on military hydrofoils to the NATO Naval Armament Group's (NNAG) permanent Information Exchange Group (IEG) on Ship Design, IEG #6, at the request of Captain Al Carrier of Op-72. Op-72 was responsible for the U.S. Navy's international information exchange agreements.

The following month, also at the request of Op-72, Boeing's former Tucumcari Program Manager, Gene Myers, gave a presentation to the French Navy. On the same trip Myers also made a presentation to the German Navy, but this time at the initiative of a Boeing consultant, General Hentz, Bundeswehr (ret.). The principle German participant at this meeting was a civil servant, Mr. Von Knobloch, the Bundesmarine's chief architect specializing in hydrofoils.[29]

In November, Myers was back in Brussels for the next NNAG IEG 6 meeting, which had since set up a provisional sub-grouping Special Working Group (SWG) on Small Missile Craft. This SWG was also numbered 6, but for a different reason. This was the sixth such provisional SWG set up by the NNAG. A second presentation was given by the U.S. Navy, this time on a 'Double Tucumcari' design (928-33H), incorporating two Rolls Royce Proteus marine turbine engines. Later the same month Chuck Slater of the Boeing Rome Office was up in Bergen, Norway at a Fast Patrol Boat Conference. It was on this occasion that the interest of the German Navy was first engendered, in the persons of a Captain Klose and Commander Max Mueller of the Fuehrungsstab Marine (FueM, or the German Navy General Staff). Klose later was to become head Sea Admiral for the German Navy and Mueller was to run the German PHM Project office in Bonn.[30]

In December 1969, Boeing provided a cost estimate on the 'Double Tucumcari' to Captain Max Cooke of the OASD/ISA (Op-723B), who transmitted it to the SWG-6 members during its January, 1970 meeting.

Following up on the January meeting of NATO's SWG-6 in Brussels, Myers held technical discussions in Bonn with the Technical Division (DivT) of the German MoD (Von Knobloch was again the principal German participant) and in Britain with the British Navy and Yarrow Shipyard. The latter involved the first move to interest European industry (in addition to governments) in participation in Boeing's next generation military hydrofoil. Later the same month, came a meeting with a senior British civil servant, Jack Daniels, Director of War Ships for British Shipbuilding.[31]

In April 1970, Myers headed up a Boeing team that held further technical discussions in Bonn with the German MoD's DivT and in Bath with the British Navy.

In late summer, the USN committed itself to deployment of the Tucumcari to Europe. This was a major program milestone for the PHM in that it showed the USN was now committed to continuing its recently frozen hydrofoil efforts. Capt. Larry Kelly succeeded in obtaining the support of the new Chief of Naval Operations (CNO), Admiral Zumwalt for a limited European deployment of the PGH-2. At a NATO SWG-6 meeting in Brussels in September 1970, the USN gave a presentation of the PX(H) design, later renamed PHM. It was the same meeting that the USN announced it would deploy the Tucumcari to Europe the following spring.

In addition to supporting the NATO presentation in Brussels, later the same month a Boeing team participated in another round of technical discussions with the British Navy in London.[32]

Meanwhile, discussions with the Germans had begun to rapidly pick up momentum in late spring and in May and June there was a further round of technical and business discussions with DivT, FueM the Bundesamt fuer Wehrtechnik und Beschaffung (BWB),[33] and the German technical support contractor Marinetechnik Planungs-Gesellschaft (MTG) of Hamburg. In July 1970

Myers gave another presentation in Bonn to the FueM and DivT covering three alternative designs each with a different engine: four Lycoming TF35C's, one G.E. LM 1500, and the 2 Rolls Royce Proteus.[34] By this time, some skepticism

was beginning to surface in the German Navy as to whether the NATO project would ever get underway. Consequently, the Bundesmarine was beginning to consider a national solution to its requirement.

b. The Bundesmarine Moves towards a Unilateral Solution to the Military Requirement

The Bundesmarine plays an essential role in denying the Warsaw Pact quick and easy dominance of the North Atlantic by performing several NATO assigned missions in the Baltic. Those missions for which the Bundesmarine was considering the adoption of a military hydrofoil to replace its conventional fast patrol boats were:

- Shadowing Major Combatants—Prior to hostilities, shadowing of major combatants, particularly large amphibious ships and heavy missile cruisers is essential to ascertain intent, determine magnitude of the buildup, act as a tripwire, be in a position to counterstrike the high value targets, and transmit an attack warning if hostilities begin.

- Minefield Defense—As the Soviets have invested in several hundred minesweepers, it is presumed that these ships would be in the vanguard of the attack forces exiting the Baltic. Forces would be committed to counter those minesweepers.

- Interdicting Amphibious Task Groups—By careful and deliberate target selection, a mission kill on a task group can be achieved by a relatively small number of effective surface combatants.

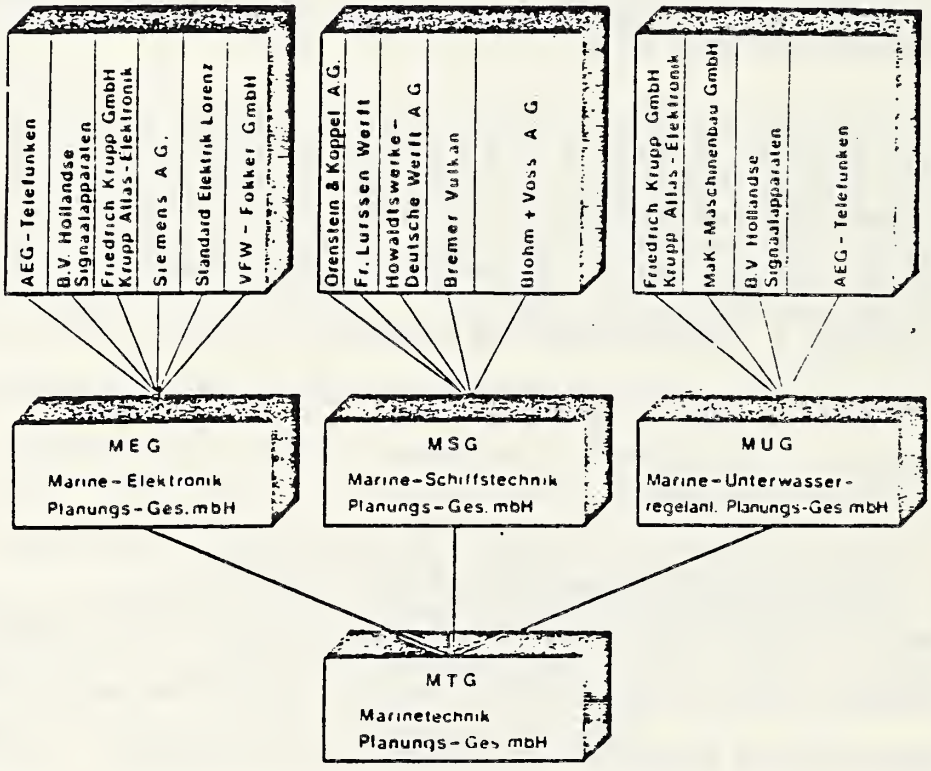
In mid-1970 the Bundesmarine canceled its own low-level four year effort for a hydrofoil for Baltic Sea missions, realizing that it couldn't catch up with Boeing.[35] In August and September 1970, a Boeing team entered into discussions at MTG directed toward the development of requirements for a new German hydrofoil, designated by MTG as the Kleines Kampfboot (KKB)-162.

Boeing technical assistance to the Bundesmarine picked up again at the end of 1970 and continued through the first half of the following year. Once again they were working with the Bundesmarine's support contractor, MTG, in Hamburg. In November a Boeing engineering team led by Dick Merritt was sent to Wilhelmshaven in northern Germany to provide assistance to the Bundesmarine's Marineamt, in development of the German military requirement.[36]

c. Marinetechnik Planungs-Gesellschaft (MTG) mbH

When the Federal Republic of Germany began to rebuild its armed forces in the mid-1950's, the original approach adopted involved the award of contracts for both design and development of warships to one contractor. By the mid-1960's it had become apparent to many that this approach to acquiring warships should be changed. Contracting with a large number of shipbuilders to develop the vessels was felt to have resulted in a less than adequate arrangement because of the resultant coordination difficulties, especially with respect to weapon systems integration. Moreover, following the conclusion of a program, some of the shipbuilding companies frequently dissolved their design offices which led to the loss of advanced know-how. Consequently, The German Ministry of Defense directed industry to establish one private company to serve as the Bundesmarine's permanent planning and design center, working under contract to BWB on all FRG naval shipbuilding programs.[37]

M A R I N E T E C H N I K



SHAREHOLDERS OF THE GROUP OF COMPANIES

Following the initiative of the Ministry of Defense, Marine-Schiffstechnik Planungs-Gesellschaft (MSG) mbH was founded by five shipyards, whereas six companies of the electronic industry founded the Marine-Elektronik Planungs-Gesellschaft (MEG) mbH. As a common instrument for all outside contacts, the companies founded the Marinetechnik Planungs-Gesellschaft mbH.

The three companies started their operation in 1966 when the participating industrial companies transferred experienced engineers to the new companies, which formed the nucleus of the new engineering staff.[38]

MSG (capital DM 300 000) is owned by the following five shipbuilding companies: Blohm & Voss AG (40%), Howaldtswerke Hamburg AG (18%), Bremer Vulkan (18%), Friedrich Luerssen Werft (15%), and Lubecker Maschinenbau AG (9%).

MEG (capital DM 300 000) is owned by Friedrich Krupp Atlas-Elektronik, AEG/Telefunken, N.V. Hollandse Signalapparaten, Standard Elektrik Lorenz AG, Siemens AG, and Vereinigte Flugtechnische Werke GmbH (VFW), each holding a 1/6 share.[39]

In 1972 a third company became a MTG shareholder, the Marine-Unterwasserregelanlagen-Planungsgesellschaft (MUG) mbH. This company had been founded in 1967 and is engaged in the field of underwater warfare.

All four companies have their offices in Hamburg, where they are located in one building. Their work ties them closely together and they regard themselves as one unit.

The Marinetechnik (MTG) group employes a total of 280 people. 200 of these are engineers. All are experienced naval architects, electronics and weapons people who are assigned to MTG by the shareholding companies.

Since Marinetechnik is working for the government and its shareholders are competing among themselves, it is generally understood and agreed upon by all parties involved, that the company must observe strict neutrality. Each employee therefore has committed himself in writing not to forward any private information he has received from any partner to any third party, without prior agreement by the originator. Being a planning and design agency, Marinetechnik has no interest in delivery of hardware. This provides some degree of assurance that the company is able to minimize conflicts of interest.[40]

The planning and design of all the Federal German Navy's surface ships has since been entrusted to Marinetechnik. In the case of warships or other naval weapon systems, Marinetechnik is the only industrial company to receive direct contracts for the Preplanning and the Concept Phases.[41]

d. Germany's MTG and Boeing Team Up to Develop System Specifications for the KKB-162 under Contract to the BWB

In August 1970, Boeing was requested by the German MOD to offer a hydrofoil boat design as an alternative to that of its own. Meeting in Hamburg at MTG in late August, one of MTG's two co-directors, Hans-Joachim Fruendt, indicated MTG's strong interest in becoming a subcontractor to Boeing for the German program. This was part of a general effort by MTG to expand its clientele to include industrial firms. The two Boeing representatives at the meeting,

Dick Merritt of Boeing Seattle and W. W. Mueller of Boeing International Corporation (BIC) Bonn Office, expressed Boeing's interest in MTG's help, especially in the areas of regulations and cooperation with the German Government, as well as interpretation of military requirements.

Herr Fruendt suggested that MSG could assist Boeing during the proposal phase not only by supplying information on German Navy Standards and Regulations and equipment selection, but cooperate with Boeing on a purely technical basis, in particular in the areas of: weight studies, compartmentalization, ventilation, noise and heat insulation, interior layout, power plant installation, electrical wiring layout, and electrical power requirements.

The following month Boeing awarded a subcontract to MTG to assist in proposal preparation in Seattle over a six week period. The technical assistance contract was for:

- a marine engineer familiar with outfitting, furnishing, and mechanical subsystems;

- a logistics specialist familiar with manuals training, spares, and the general logistics requirements of the Bundesmarine, and;

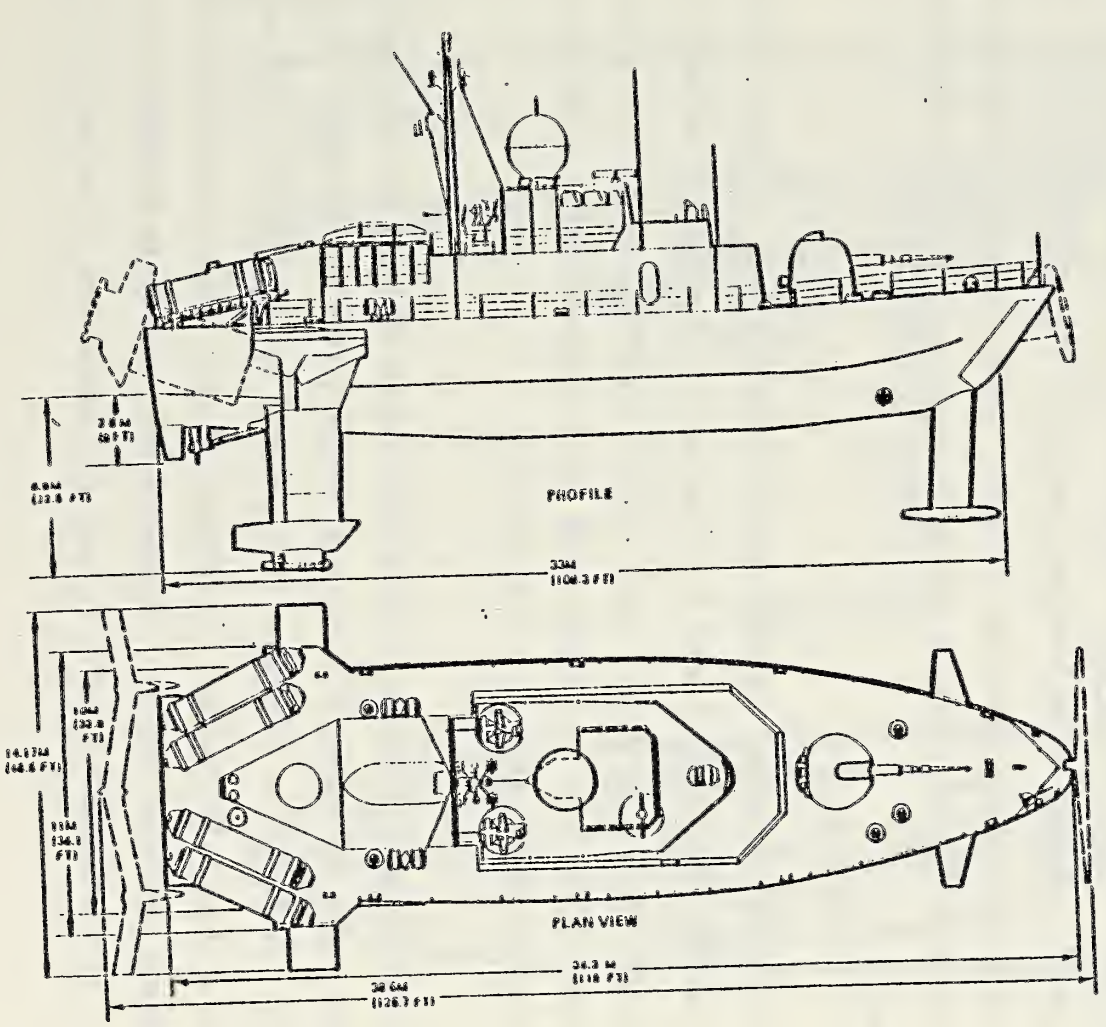
- an electronics engineer familiar with weapon systems and electronics integration.

The MTG personnel also brought with them catalogues and other appropriate data with which to assist Boeing in the selection of components and standards.

(1.) Boeing offers its hydrofoil ship design, designated the Model 928-70. The Boeing Model 928-70 design was for a 230-ton 36.3 meter submerged-foil ship that was based on the much smaller Tucumcari, utilizing turbine powered waterjet propulsion, and designed specifically for Bundesmarine and its NATO assigned operational responsibilities in the Baltic Sea. In a slightly modified form this Boeing/Bundesmarine design would eventually become that of the NATO/USN PHM.

All major technical features of the ship design were derived from a proven technology base. As with the Italian P-420 Spaviero, the ship configuration had been established to incorporate an advanced combat system that was consistent with the significant advance in the area of the weapon platform represented by the submerged-foil hydrofoil concept. As configured at that time the weapons suit included a 76-mm OTO Melara gun, four Exocet anti-ship missile installations, the HSA WM-28/52 FCS,[42] and two 20 mm guns.

The Boeing Model 928-70 was designed for the Bundesmarine for operation in the Baltic Sea on an all-weather basis, i.e., in significant wave heights of 3 meters. Speeds of 50 knots could be maintained without exceeding the continuous rating of the main turbine engine. The ship had a foilborne range well in excess of 400 nautical miles. The turning diameter while foilborne at continuous power was well below 500 meters, in heavy seas as well as in calm seas. The ride qualities of the ship in terms of hull accelerations in heavy seas were



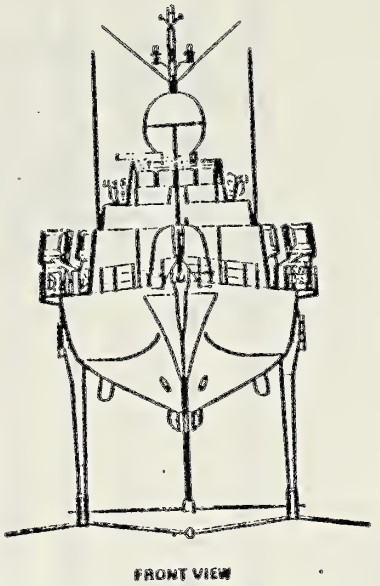


Figure 3.1-1: MODEL 928-70 EXTERNAL ARRANGEMENT

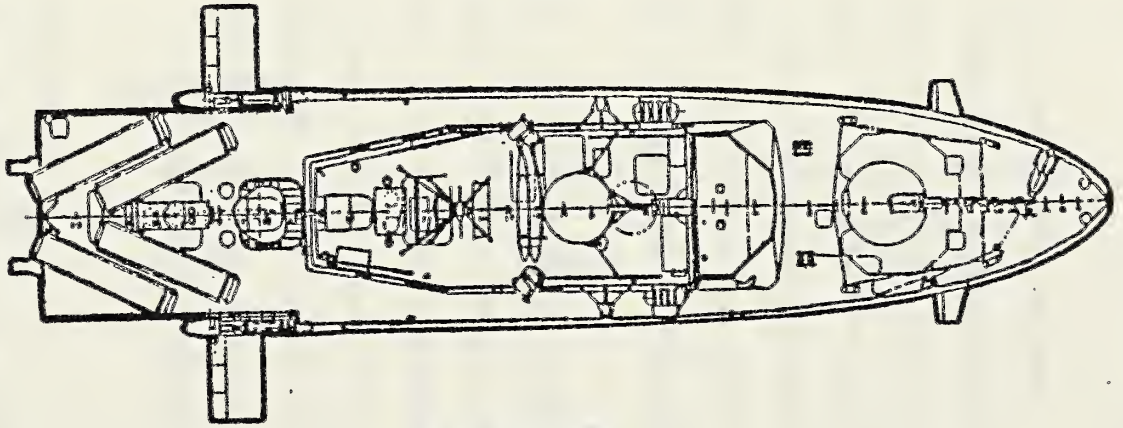
comparable to those of conventional ships of far greater displacement. Hullborne, the Model 928-70 would provide the advantage of improving hullborne seakeeping by extending the struts.

Boeing emphasized that its capability to design and construct the Model 928-70 for the Bundesmarine was the result of over ten years experience in pioneering the development of submerged-foil hydrofoil ships. This experience encompassed all of the major hydrofoil programs of the U.S. Navy previously covered in Section 3 of this sub-chapter; the PCH-1 High Point, FRESH I, Plainview and Tucumcari, as well as the privately developed HTS and Little Squirt. The high performance design features of the Model 928-70 also permitted the application of the aircraft experience of Boeing in addition to the ship construction experience.

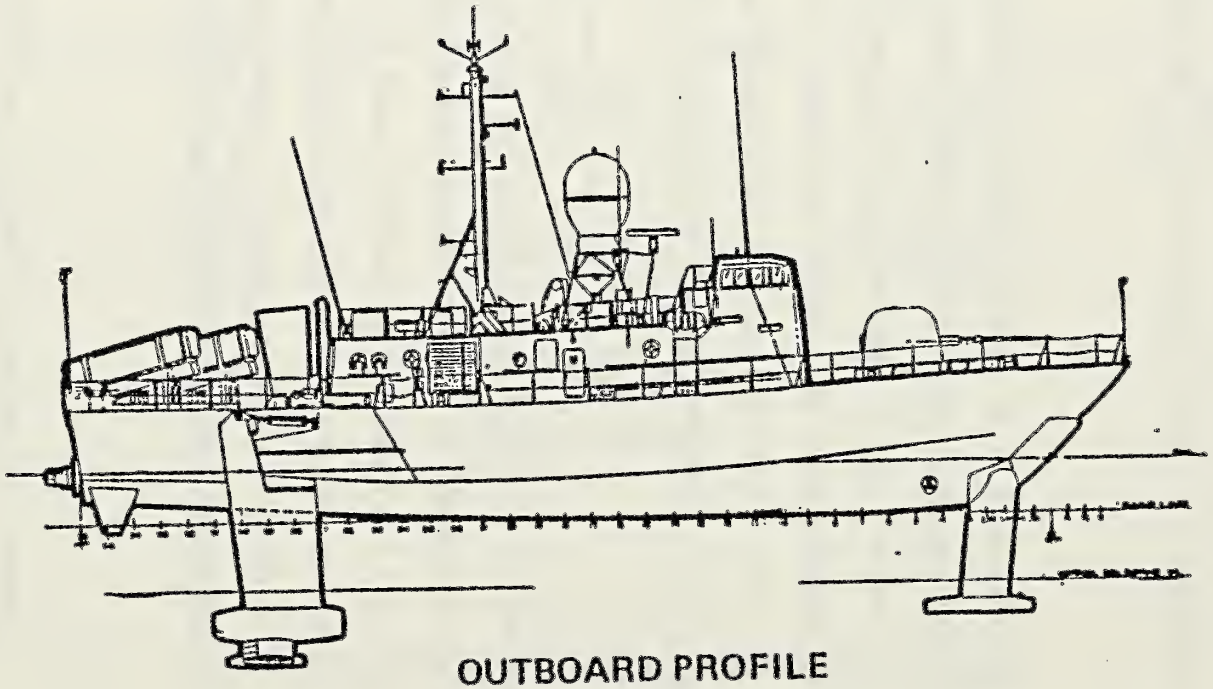
The specific design of the Model 928-70 hydrofoil ship involved a high-strength all-welded aluminum hull with foils and struts of corrosion resistant high strength steel. Foils and struts were configured to reduce to a minimum the motions of the ship that result from the disturbed surface of the sea and from the associated orbital motion of the water.

The turbine-powered waterjet propulsion system utilized two dual-section centrifugal pumps which were to be derived directly from the Tucumcari design. Electrical power for the ship was to be supplied by a 115/200 volt 400 Hz system that yielded major savings in equipment weights, consistent with the high performance nature of the ship. Hydraulic power was to be provided by two identical aircraft-type hydraulic systems with provisions for automatic transfer of

S 162



PLAN VIEW -



OUTBOARD PROFILE

critical loads in the event of damage to one system. Foilborne control of the ship was to be accomplished by a full-time automatic control system that required no attention on the part of the crew once takeoff has been completed. This system provided attitude stabilization, automatic control of foil-depth, automatic banking in turn maneuvers, and automatic alleviation of seaway disturbances.

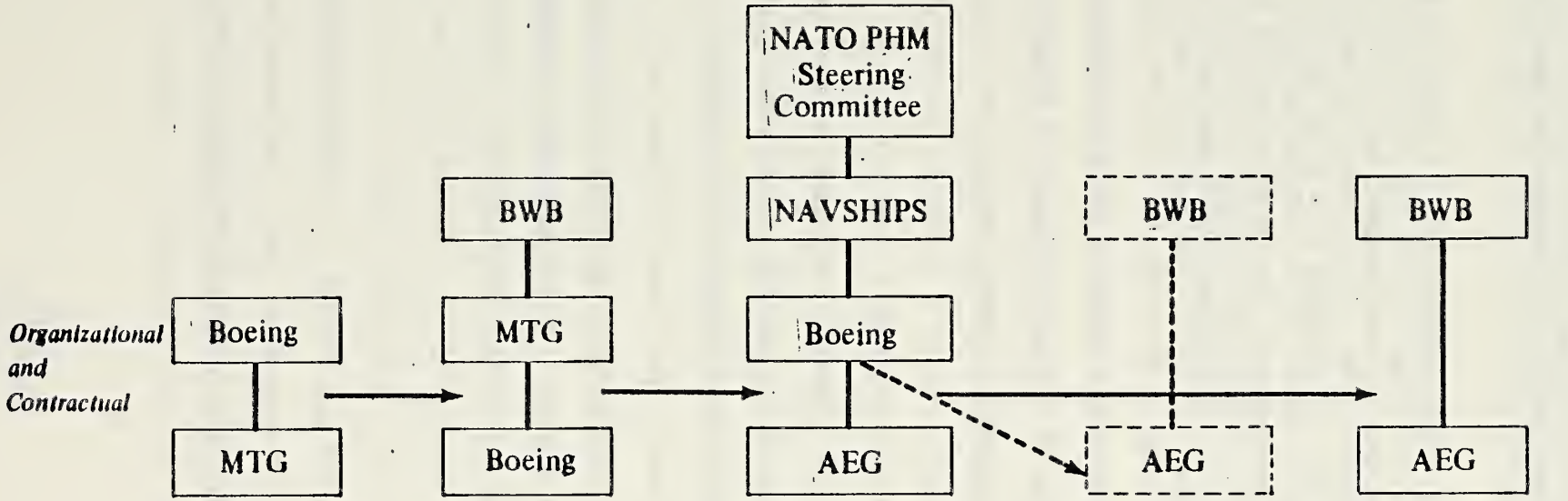
(2.) Development of the KKB-162 system specification under contract. In preparing its proposal for the development of the KKB-162 Weapon System, it had become clearly evident during November that the specifications governing the Weapon System were lacking. The German government was demanding full proof of performance. Consequently, Myers decided that it was necessary to backup and reach a complete contractual definition first, prior to proceeding with the developmental proposal.

With its Model 928-70 hydrofoil ship, Boeing had already completed five of the seven subspecs for the 230 ton KKB-162 ship system specification in the area of: hull structure; machinery (e.g. propulsion systems and power generation); the electric plant; auxiliary systems (e.g. environmental control systems and fresh water system); and furnishings. However, Boeing lacked the data necessary to complete the communication and control systems subspec or to even begin to tackle the armament subspec.

In order to reach adequate contract definition for firm pricing and scheduling of the entire Weapon System it was essential that Boeing develop KKB-162 Weapon System specifications and baseline definition. MTG, with its background in

The German Military Requirement

1970-1977



	Boeing Model 928-70	KKB-162	PHM-1	S-162	S-143A
Designs	Design	Specification Contract Definition	Lead Ship Design and Construction	Design (German national variant of PHM)	Series Production of Conventional Fast Attack Craft

1970 1971 1977

preparation of similar data for the S-143 and the German Frigate Program, had the capability and was a logical choice as a partner for developing this data.

Consequently, in a December 4, 1970 letter to MTG's Fruendt, Gene Myers made MTG an offer. Myers proposed that the most expeditious way to prepare these specifications would be for MTG, to undertake as a prime contractor the job of Weapon System specification development. Boeing would provide technical assistance to MTG to insure definition of an integrated system including the hydrofoil ship. Boeing's objective would be to develop a set of specifications acceptable to both BwB and Boeing and thereby facilitate contract definition and agreement. Boeing then would be ready to prepare a formal proposal for development of the Weapon System as a separate response to the specifications developed by this effort.

As a result of the proposal Boeing and MTG negotiated a technical assistance agreement[43] over the following month that resulted in MTG's award to Boeing of a cost plus fixed fee contract on January 11, 1971 for $133,805. The agreement covered 94 man-weeks of technical support over a 14 week period extending from January 11 and May 23, 1971. The work was to take place primarily in Hamburg at MTG. Merritt was on-site manager in Wilhelmshaven of the Boeing technical team, one fluctuating between three and five people over the first five months of 1971.

More or less simultaneously, MTG was awarded a 1 million DM ($250,000) study contract from the German MOD's Procurement Agency, the Bundesamt fuer Wehrtechnik and Beschaffung (BWB), to develop specifications for the new KKB-162

hydrofoil design. The total effort eventually performed under the MTG-BWB contract came to 1,097,000 DM by the fall of 1970.

As previously pointed out, the KKB-162 specification was to evolve, after a compromise with the USN later in 1971, into a slightly modified version which became the NATO/USN PHM design. In the words of Gene Myers:

> Without the KKB-162 study, the background work would never have been done that allowed the PHM to go forward. The KKB-162 study forced the PHM in the direction that it finally took in size, speed, and range.[44]

Upon completion of the KKB-162 contract definition study Boeing began preparation of its firm-fixed price proposal to the FRG for ten KKB-162 hydrofoil ships, the first to be launched 28 months after contract award. However, these efforts were abruptly terminated[45] by a rapid succession of events, starting the same month with the Tucumcari's deployment to Europe which shifted the focus of the Bundesmarine away from a national solution and back to a NATO one. This European deployment proved to be the needed catalyst which finally lead to initial agreement on a larger NATO hydrofoil project.

e. The USN/Boeing PGH-2 Tucumcari is Deployed to Europe and the USN sponsors the Launching of the NATO Project

Technical discussions continued in parallel between Boeing and the Bundesmarine during January and March while the KKB-162 study was underway. March 1971 also saw another round of these discussions with the British Navy, and for the first time, the Danish Navy.

Per the CNO's approval the previous year, the USN's Tucumcari was shipped across the Atlantic from Norfolk, Virginia on an LST for demonstrations in the FRG

and Denmark in April and May 1971. Boeing provided support for the deployment. A special ad hoc meeting of NATO's SWG-6 was held aboard the Tucumcari during one of these demonstrations in Denmark. The PGH-2 Tucumcari's performance was impressive and succeeded in completing the process of locking the FRG in on the PHG-2 Tucumcari based design. Grumman representation in Brussels during the NATO Project Group 6 deliberations ended shortly thereafter.

The Tucumcari demonstration at Olpenitz in the FRG made a good impression in spite of an engine failure and bow door failures. Not all of the VIP's invited made it even after the demonstrations were rescheduled three times, but those that did ride the PGH-2 were enthusiastic. A large number of MTG personnel, however, were able to ride Tucumcari because of these delays.[46]

Tucumcari demonstrations in the United Kingdom had fewer hitches with equipment problems and were generally very successful. Joint operations with the Vospers Tenacity fast patrol boat and several air cushion vehicles showed that the fully submerged hydrofoil was vastly superior in speed, comfort, noise level and maneuverability.

As this was all going on, pressure began to build up for the FRG to release its KKB-162 study. It was understood that if the FRG was really serious about influencing the U.S. in the "circular of requirements" for the NATO PHM program, those specs had to be available to the PG-6 Group by mid-summer.[47]

After the demonstrations in Northern Europe the Tucumcari continued down the Atlantic coast and traveled the length of the Mediterranean. Demonstrations

were given in Greece, Turkey and Italy. Upon completion the Tucumcari returned to Italy where it was loaded back on the LST serving as its support ship, and headed for Norfolk, Virginia.

As a result of these demonstrations, the Bundesmarine's commitment to the KKB-162 hydrofoil design based on a quadrupling of the Tucumcari, became rock solid. Representative of this milestone, the MTG originated KKB-162 designation was replaced by a new designation provided by the Bundesmarine, S-162 ('S' for Schnellboot).[48]

In June 1971, NATO PG-6 met in London and the British, Canadian, U.S., German, and Italian navies began to move toward a concensus on a joint program based on the Tucumcari. It was at this meeting that the U.S.N. committed itself to building two PHM lead-ships if a design satisfactory to at least one other NATO Navy could be arrived at. The Bundesmarine offered no official response at the meeting, but U.S.N. personnel began to get the feeling from private conversations that they would soon join.

It was during this period that Boeing, having signed an agreement with France's Aerospatiale to produce under license the French surface-to-surface Exocet naval missile earlier in 1971 (if they could sell the U.S.N. on it), made a final attempt to get the French Navy interested in joining the hydrofoil project. The idea was to tie the Exocet in with the PHM as a 'quid pro quo'. As it was the French Navy never became seriously interested in the nascent NATO PHM program, nor did the U.S. Navy adopt the Exocet (a sea-skimmer missile)

preferring to proceed with their own McDonnell Douglas Harpoon project, the missile that was later to equip the U.S.N. PHM's.[49]

By June 1971 the USN had finally assumed the helm, taking over from the Bundesmarine and Italy as the principal sponsor of a Tucumcari based follow-on system. Though the USN had taken a leadership role in sponsoring NATO hydrofoil activities, up to this point it had been wedded to a Grumman PGH-1 based design. This was the case even though other elements in the Pentagon had prevailed in selecting the PGH-2 Tucumcari (with its better record in the area of reliability) for the European demonstration.

The Chief of Naval Operations (CNO), Admiral Zumwalt, made his support official in August. The OMB and GAO also became actively involved at this point, working to support this effort by making sure that the joint program went smoothly, especially with regards to stream-lining the formal source selection process. Both organizations supported the idea of a NATO project as good for both NATO, and the U.S. image in particular. Worthy of note is that OMB support came in the person of Dr. James Schlesinger, shortly to become Secretary of Defense.[50] DSARC I was completed in November, 1971.[51] On November 24, 1971, Boeing was awarded a sole source contract for a feasibility design study by the Naval Sea Systems Command in Washington, D.C., for $5.9 million.

5. Boeing as Entrepreneurial Coordinator for the NATO Naval Armament Group (NNAG)

In parallel with the NATO activities in Brussels, throughout 1970 and 1971 Boeing was discussing advanced hydrofoil designs with several NATO navies, each navy being presented technical data individually. The Boeing effort was two pronged. The American, British, German, Danish and French, navies were being approached by Seattle-based Boeing personnel. Al Smith and Joe Spontak worked with the U.S.N., and Gene Myers and Dick Merritt handled Northern Europe. Myers and Merritt were assisted by General Hentz and Werner Mueller of Boeing's Bonn Office. Boeing was working with the Italian Navy through its Rome office, in the person of Chuck Slater, and its recently formed Italian affiliate, Alinavi (60% Boeing-owned), in the person of Publio Magini. Alinavi was already under contract to the Italian Navy to design and construct a modified version of the USN/Boeing PGH-2 Tucumcari, the P-420 Spaviero.

During this period, Boeing actively managed the flow of data to the interested NATO navies. By the late spring of 1971 the German and Italian Navies had been locked in on Boeing designed follow-on ships to the Tucumcari. The two navies made it clear to the USN that if they were to participate in a joint NATO miliary hydrofoil project, it would be for an enlarged version of the Tucumcari. The USN came around shortly thereafter and definitively (if not belatedly) selected the PGH-2 over the PGH-1.[52]

The dynamics of the Special Working Group 6 and the subsequent Project Group 6 meetings of 1970 and 1971 are particularly interesting. First, there was a

problem with regards to the importance of the agenda for each meeting. The US Navy had some difficulty with the importance attached to a strict adherence to the agenda by their European counterparts, and effectively working within it. While the USN reps had greater latitude and could work towards the fulfillment of policy objectives, the European representatives of the navies were highly instructed, all decisions having been made independently prior to the joint session and pre-recorded in considerable detail.[53]

In mid-1971, in an effort to up-grade the meetings and allow for more on-the-spot decision making, the USN began to send a Rear Admiral to the PG-6 meetings. The others followed suit, but this did not circumvent the agenda conflict. The work and decision making for such meetings takes place elsewhere, in the national capitals. The Brussels meetings were necessary to formally exchange these national positions, and endorse any points of accord.[54]

Secondly, the inter-Navy coordination work had to be accomplished early so as to allow time for its digestion prior to the next NNAG Special Working Group 6/Project Group 6 meeting. The USN tried to handle this task itself, but usually came in with too little, too late. With this in mind, Boeing in the person of Gene Myers, assumed the role of entrepreneurial coordinator. Myers presented the supporting data and assisted in working out positions in detail in the Northern European national capitals on a one-to-one basis prior to each meeting. Though industrial representatives are not allowed to be present at the meetings of NATO's CNAD, its Main Armament Groups (of which the NNAG is one), or any of their sub-groupings, Myers presence in Brussels was critical. This was because the exchange of views and data between governments was handled

more effectively outside of the official meetings, away from the minute takers. This included social gatherings as well. A great deal of the Brussels work for the NATO PHM was accomplished in this less formal environment, and here an industrial rep such as Myers could participate effectively.[55]

Thirdly, in the NATO SWG for Small Patrol Craft (SWG-6) and later PG-6, each representative from the larger nations came in supporting their own national technical solutions, as one might expect. The British Navy supported two different concepts as represented by the Vospors planing boat and the SRN Hovercraft, the French pushed their 200-ton Saphyre hydrofoil design, the Canadians had a deHaviland hydrofoil design, the Germans originally supported their own hydrofoil design, and later the Boeing Tucumcari based KKB-162, and the USN promoted its PGH-1 and PGH-2 hydrofoils (with a bias toward the former). Gradually as 1970 progressed, Boeing efforts in their respective capitals suceeded in weening the German and British Navies away from their national designs and over to Boeing's PGH-2-plus design. Even after this had occurred though, these two navies continued for some time to give official support to their national designs in the PG-6 meetings, while privately admitting, away from the minute takers, that an advanced hydrofoil based on the Tucumcari was the preferable option. Moreover, as previously mentioned, the German navy terminated their own hydro-foil studies in the summer of 1970 and placed a six-month DM 1 million study contract with MTG and Boeing several months later. The British Navy, unfortunately, never found the funds to follow-up their interest with anything more concrete.[56]

Among the most active navies in NATO's SWG-6, Exploratory Group 2, and PG-6, the Italians were the one exception to this rule of each Navy pushing its own national design. Having already opted unilaterally to go ahead with the construction of a derivative of the Tucumcari, the Spaviero, they supported Boeing designs for a follow-on ship based on the Tucumcari from the begining, even before the USN. Of particular importance was the role played by one of the Italian Navy's representatives at the SWG meetings, Publio Magini. Dr. Magini was working as a consultant to the Italian Ministry of Industry. He also happened to have been the President of the joint Boeing-Italian firm Alinavi at this time. Unlike the other major allied nations, for NATO working groups, Italy relies heavily on technical support contracted for from industry. This is somewhat of a grey area as such firms are often partially (as was Alinavi), or totally state-owned. As a matter of principle, the competing national contractors are excluded from NATO meetings; NATO being, of course, an intergovernmental body. Magini brought hydrofoil technical expertise to the Italian delegation, in addition to greatly facilitating communications among the U.S. and Italian Navies, and Boeing.

> Magini's role in getting NATO to accept, first, hydrofoils, and secondly, the Boeing design formula was crucial. His position was ambiguous, being simultaneously Boeing's Corporate consultant in Italy, President of Alinavi and a consultant to the Italian Navy delegation. Because of his deep technical knowledge of Boeing hydrofoils, he was able to sell not only the Italy delegation, but various other delegates on the Boeing approach. He was able to understand what the individual and national delegation positions really were, act as a catalyst in arranging key meetings and, acting within ethical limits, keep Boeing as informed as possible of what was really happening. In short, Magini's contribution was invaluable.[57]

A fourth and final point interrelated with the above concerns the ever present US - European conflict with regards to the business-government relationship

and competition policies. The European governments are inclined to work with a designated contractor, whereas the U.S. Government must keep competition in the picture for a more prolonged period during the early phases of the acquisition process. In the case of the NATO PHM project, although the Boeing-USN working relationship was a good one, it was evident that the USN felt much more constrained in dealing with a potential contractor, than their German or Italian counterparts. Gene Myers found that communication was often easier with the German and Italian navies than his own.[58]

Consequently, Boeing ended up selling its own navy on the merits of: 1) a PGH-1/PGH-2 follow-on project; 2) the design ultimately selected and 3) one with Boeing as the contractor—through the median of the two allied navies. In this role of advocate, the Italian Navy played the predominant role up through the completion of the German Navy's KKB-162 study contract with Boeing in mid-1971. During the second half of 1971 both Navies were about equally supportive, but during 1972, the German navy assumed the primary role in negotiating with the U.S. Navy over the ultimate design of the PHM. The Italian navy assumed a neutral posture during this period, remaining open to whatever mix of the other two navies design preferences eventually prevailed.[59]

6. The Concept Definition Study Contract Award (November 1971) and the Lead-ship Construction Contract Award (February 1973)

With the agreement in mid-1971 by the British, Canadian, German, Italian and U.S. navies, upon the PGH-2 as the basis of a follow-on project, the representatives within NNAG Project Group 6 began to oversee the negotiating of the definitization of project management and funding arrangements amongst the engaged nations. After several PG-6 meetings in the various allied capitals during the summer, the five engaged nations were able to take the next step and sign letters of intent.

In October, Captain Jim Wilkins (USN) was designated to be the Patrol Hydrofoil Project Manager, and Gene Myers was selected to be the Boeing PHM Program Manager.

a. Concept Definition Study (Phase I)

The sole source study contract was awarded by the USN on November 24, 1971,[60] for a matrix design study which was to be Phase I of the NATO project.

The United States agreed to commence unilaterally with the design feasibility studies necessary to establish a common baseline capable of meeting each of the engaged nations (since reduced to three) specific operational requirements. This did not involve a clean specification, but only a general statement of work covering the ranges between the USN position of a 140 to 170-ton propeller driven hydrofoil, and the German's 230-ton water-jet propelled hydrofoil design which had in the interim received the designation of S-162.

The original USN position originated from in-house studies carried out by the Naval Ship R&D Center (NSRDC), a USN laboratory located near Washington, D.C., in Carter Rock Maryland.

The German position rested on the KKB-162 study carried out under contract by MTG and Boeing in the first half of 1971. The U.S. Navy originally thought that the Bundesmarine might be satisfied with a ship in the neighborhood of 180 tons, but Von Knobloch made it clear to Boeing's Bonn representative, Mueller, in early July that the FRG would join only if the U.S. agreed to the German requirements. The FRG was in a particularly good position to influence the outcome of this debate because of having the KKB-162 specification.

In July, 1971 a U.S.N. team visiting the FRG was presented with the results of the KKB-162 by the MOD's Armament Division with Von Knoblock presiding, and was surprised at the detail and the overall work. The presentation tended to disprove a number of the USN's assumptions on their 170 ton boat. Assumptions for fuel consumption were particularly questionable. The Bundesmarine got the impression that the USN was still using inputs from a Grumman design. USN team was impressed and promised to send current data on the NATO boat design for comments by Division T. A meeting with U.S. Navy to provide these comments was agreed to for September.[61]

The U.S. Navy ultimately swung over to a 230-ton water-jet propelled design by early the following year. Meanwhile, Boeing had been exploring under contract during 1972 all variables of the combination of the two designs. As the study progressed the U.S.N. agreed that the 170-ton design had several major

failings: it seriously understated the weapon suit payload, the electronics required, and the range. Contributing to the compromise being one heavily weighted toward the German position, was the German KKB-162 study having been in much greater depth than that of the U.S.N.'s own in-house technical support consultant, the NSRDC.[62]

The Italian Navy remained neutral throughout this process as the other two navies attempted to reach a concensus. In spite of this position of neutrality, Italy did continue to express its concern that the system was evolving in a direction contrary to its concept of what was called for to fill its requirement in the Mediterranean environment. The Italian concept emphasized a small, highly maneuverable craft that could operate on a highly dispersed basis in an inland sea. The idea was a low-cost, disposable system with minimum complexity that could be utilized more as a pure weapon.

As the design began to stabilize on the larger ship originally envisioned by the Bundesmarine, the Italian Navy saw itself assuming a share of the ever greater technical risk and cost that went along with the increased sophistication, tonnage, and crew size.

Using the results of the common NATO design baseline, the effects of applying the individual national variations were investigated parametrically by the contractor. Upon completion of these studies in February 1972, a family of designs which satisfied both the common and individual national require-ments were presented to the provisional NATO Project Steering Committee[63] for use in selecting ship commonality characteristics for the NATO Standard PHM Baseline.

Final studies in March 1972 established the feasibility of adapting the Standard PHM design to meet the requirements of each national variation.[64]

Project Engineering at Boeing spent most of the rest of 1972 investigating various iterations of the detailed design, and supporting a series of preliminary design reviews (PDRs). (At one point, mid-year, a smaller 140-ton design resurfaced and had to be dealt with once again.) Meanwhile the NATO Offset Plan Manager, Dick Merritt, explored various equipment options with the aim of introducing as much German and Italian content as feasible into the ship design, while NATO Weapon System Manager, Al Smith, investigated national weapon system requirements and alternative systems available (e.g., for the FCS, systems from the Dutch firm HSA, France's Thomson-CSF, and several Italian manufacturers.)

Phase 1 was completed in December 1972, culminating in a mutually agreed to NATO Standard PHM contract design and the United States variation design. During this phase, two significant documents, the Ship System Requirements and the Ship System Description, were prepared. Together, these documents provided the basis for establishing a contract design. The Ship System Requirements document, expanded from the original NATO Circular of Requirements, contained all the requirements the ship design had to satisfy. Additionally, it incorporated the feasibility design baseline resulting from the February 1972 provisional Steering Committee meetings. The Ship System Description document contained the description of the design as it had evolved from the periodic design reviews. At the conclusion of the contract design phase in late 1972, all major equipment to be included in the Standard Ship design had been selected, all subsystem configurations confirmed, and procurement of long lead equipment

undertaken. Earlier allocations of space, weight, power, costs, and risks had been verified and established.[65]

b. The Hybrid Metric Design

Not only was the ultimate design heavily influenced by an allied navy, but this was to be the U.S.N.'s first experience with a ship based primarily on the metric system. The NATO PHM Ship Standard Design (i.e., that element of the design common to participating navies) utilized a hybrid metric system for weights and measures, i.e., metric except where selection of non-metric equipment already existing and proven in a similar application was dictated by considerations of cost, design tradeoffs, or balance of payments. In addition, per the MOU, the design took into account industrial, commercial, and Governmental material standards applicable in the Participating countries. Moreover, in the interests of economical construction and mutual logistic support, NATO Standardization Agreements (Stanags) were to be applied to the maximum extent feasible. For NATO PHM Ship Variation Designs (i.e., the national peculiar elements of the design) the system of weights and measures to be applied were to be those selected by the Participating Government(s) on whose behalf any such Design was ordered.[66]

c. The NATO Project Management Organization Falls into Place

When the provisional NATO Patrol Hydrofoil Project Steering Committee (NPHPSC) first met in Washington, D.C., in January 1972, it began to oversee the work of formalizing the protocol between the three engaged NATO nations and their attempts to arrive at a common design.

The second provisional NATO Steering Committee meeting took place in Seattle, Washington, at Boeing's Plant II, in February, at which time additional letters of intent (with caveats) were signed between the USN and its two allies, while work continued on the definitive MOU for lead-ship construction. The third meeting took place in the Federal Republic of Germany, in Bonn in April. All three of these meetings were of one week duration.

The provisional NATO Steering Committee's three National representatives were Rear Admiral George Halverson for the USN (later replaced by Rear Admiral Bill Reed) Herr Forndran for the FRG (later replaced by Herr Otte) and Admiral Ruzzier for the Italian Navy.[67]

Sufficient progress had been made in stabilizing the requirement and agreement on funding that by the time of the second Steering Committee meeting, the pace of work picked up on the establishment of the provisional NATO Patrol Hydrofoil Project Office (NPHPO) in Washington, D.C., at the Naval Sea Systems Command, in late February 1972. During early 1972 the German and Italian staffers made several visits of two to three weeks duration to the provisional NATO Project Office. The NATO SPO was fully manned and opened in April.

With the establishment of the NPHPO in April, Boeing began to work exclusively with the Project Office, instead of the three navies individually, though Myers continued to maintain excellent lines of communications with the three national members of the provisional NATO Steering Committee. Captain Wilkins wore two hats: one as Ship Acquisition Program Manager (SHAPM) for Project Management Ships (PMS)-391, reporting up through NAVSHIPS to the Chief of Naval Materiel

and then to the CNO; the other hat was that of NPHPO Manager reporting to the NATO Steering Committee.[68]

The NPHPO was primarily manned by Americans and followed a matrix organization (i.e. dependent on other elements of the Naval Sea Systems Command for specific administrative or technical support). As previously mentioned, the USN provided the Program Manager, Captain Jim Wilkins (replaced by Capt. Ed Molzan in November 1975) and one of three Deputy Program Managers, Commander Carl Duff (who also wore two hats). The Germans and Italians each provided a Deputy Program Manager, Sigfried Tympe[69] (FRG) and Capt. Marco Perlo (Italy). Mr. Tympe had a staff of two Germans and Capt. Marco Perlo, one Italian. Each also served as head of one functional area of responsibility.[70]

Most meetings between the NATO Project Office and Boeing during 1972 took place in Seattle, but one or two occurred in Washington, D.C.

While all this activity was taking place, NNAG Project Group 6 continued to meet in Brussels and the national capitals as a vehicle for the three engaged nations to keep the observer nations informed; Canada, Denmark, France, The Netherlands, and the U.K. These meetings continued into the early fall of 1972 on an intermittent basis, but as none of the observers elected to join by the end of one year in this status, Project Group 6 was dissolved.

As attempts to reach an accord among the three engaged navies dragged on, the fourth Steering Committee meeting occurred in July and August 1972 in Seattle, being in almost constant session through the summer. In early fall the last

PG-6 meeting took place in Bonn. In November 1972 the MOU covering a joint lead-ship design and construction program was finally signed, one year after the USN had awarded the original feasibility study contract. The U.S. government's assumption of the initiative and concommitant risk in the interim finally paid off. In the opinion of the first Boeing Program Manager, Gene Myers, "If we had waited for the MOU before going forward with the matrix design study, the project probably would have never gotten off the ground."[71]

The second phase was to provide the detailed design and construction of the two United States variant lead ships and the delivery of a complete production data package suitable for competitive procurement of ships by any of the participating nations.

d. Interim Solutions are Found for Staffing and Funding as Signature of the MOU Slips into 1972: the Case of the FRG.

The official statement, given to NATO PG-6 back in October 1971, said the FRG would provide its share of funding for conducting feasibility and parametric studies in the eventuality that the MOU was ever to be signed by the FRG. This only covered the period through February 15th, however. Signing of the MOU prior to that date would not have been feasible due to the lack of approval at higher levels. In the understanding of the German representative in October 1971, the first time they would obtain knowledge on the funds to be committed, would be in January or February 1972. The mandatory approval would then take several additional weeks.

As things turned out though, when the new year rolled around agreement upon and signature of an MOU was still not in sight. At the PG-6 meeting in Brussels in mid-February 1972, the FRG representatives were asked to give a presentation on the status of their on-going efforts to find intermediate solutions for staffing the Project office and funding the feasibility design study.[72]

The FRG (as did Italy for that matter) still needed to know the technical solution of the standard design, prior to its making a decision as to whether it would meet the Bundesmarine's requirements or not. But it was also understood that a NATO PHM Project Office could be established only after signing of the MOU. As the signature of the MOU had continued to slip, it was recognized that an intermediate solution was necesssary to enable the FRG (and Italy) to participate directly in discussions and the decision making process between U.S. Navy and Boeing Company vis-a-vis establishing the "feasibility design baseline."

The FRG had assigned the following personnel to a delegation to perform this task in January, 1972: Herr Von Knobloch, MoD, as head of the delegation; Herr Tympe, BWB, deputy naval architecture; Herr Smago, BWB, deputy weapons and electronics; Herr Rossmann, general Office of the Navy; and Herr Burgmeister, MTG's, deputy manager. A comparable team also arrived in D.C. from Italy.

The duration of this first stay in Washington, D.C. was three weeks from January 19 to February 10.[73]

During this first period in which the German delegates were working at PMS 391 in Washington, D.C., they participated in discussions and decision-making, as well ad working out different papers as recommendations to be forwarded to higher levels within the German government for approval. In particular, they worked on the final organization of the PHM Project Office, including detailed job descriptions.[74]

In early 1972, in order to keep the international program moving, the FRG found that it was expected to provide an additional commitment to PG-6 on its funding intentions during the scheduled NATO meeting in Brussels of the week of February 14-18, covering the period from mid-February through the time the MOU was signed. This they gave but only through May (at which point yet another commitment was required).

After the Brussels meeting of PG-6 the German delegation returned home. The last week of February was taken up by meetings involving:

(1) Review and approval of the technical side of the Project (or elaboration of recommendations) using available data on the feasibility design baseline, and;

(2) Review and approval of financial aspects of the project (design stage only).

At the beginning of March the German delegation returned to Washington, D.C. The second interim period of work for the FRG delegation to PMS 391 lasted

throughout the month of March. After the delegations returned to the FRG at the end of March, final agreement was reached on setting up the provisional NATO project office in April.

e. Lead-ship Construction (Phase II) Begins

Phase II of the NATO project began the following winter with the Naval Sea Systems Command's award of the Lead-ship construction contract to Boeing in February 1973.

This was not without a last minute hitch, however. Though Phase I (the matrix design and feasibility study) had resolved why the U.S. Navy had to go for a larger water jet propelled ship (and the 140 ton design had in the meantime resurfaced and been suppressed), the U.S. Navy and Boeing found themselves having to rejustify the decision to accept the 230-ton water-jet design at the last minute, prior to the commencement of Phase II.

Later, in August 1973, Boeing received an RFQ from the Naval Sea Systems Command for its first national variant work. It was for design, supply, and integration of the German PHM (S-162) Variant Ship Combat System. Though several million dollars of national variant work was later to be done under contract for the FRG over the life of the NATO project, no such effort was ever specifically contracted for in the case of Italy. As such, for Italy, national variant weapon system specifications never got past the stage of container size and weight.

f. Boeing Gets its Feet Wet with German Procurement Regulations

The August 1973 RFQ to Boeing for the German Variant Ship Combat System designated AEG Telefunken as the German subcontractor. In accordance with the Navy's RFQ, Boeing and AEG jointly prepared a statement of work for the Phase I (preliminary design) proposal preparation effort. Following Boeing's placement of a purchase order, AEG submitted a proposal in November for a little under DM 2 million.

Of interest is that, for the first time since the beginning of the KKB-162, PHM/S-162 effort Boeing had to work through German procurement regulations. In particular, the offer was quoted under Verordnung fuer Oeffentliches Preisrecht (VOPR) 30-53. The proposal used maximum cost price (Selbstkostenerstatungspreis mit Hoechstbegrenzung), that can be considered to be similar to a cost plus percentage of cost type of contract which was, of course, illegal under ASPR. But in another sense it corresponds to an undefinitized fixed price contract with a not to exceed price, be it one that is meant to stay in the undefinitized status for a prolonged period of time.

Per the German regulations, all audits and rate verification were carried out by the BWB. Boeing received the BWB audit findings report on the proposal prior to their own cost analysis. After endorsement and transmittal by NAVSEA, BWB later determined all prices, rates, maximum allowable cost, as well as indirect cost and compliance with VOPR generally. After negotiation of the contract, early the following year, Boeing transmitted it via NAVSEA to BWB for approval of the interim and ceiling cost price.

7. The NATO Standard PHM Ship Design and National Equipment Variations

It was recognized during the early stages of the ship acquisition process that a single version of the PHM, for use by all nations, was not likely. However, in order to ensure that the design, development, production, operation, and support related economies flowing from standardization could be attained, it was planned that the individual national PHM's should have similar basic characteristics. This objective was achieved by designing a standard PHM ship for multinational use, yet retaining sufficient design flexibility to allow for the individual variations of any country.[75]

The variations were primarily equipment-oriented, particularly in the combat systems. Nations were to be able acquire the standard PHM carrying the particular combat equipment compatible with their own national support systems.

The hull form and size and the major structural bulkheads and decks, foils and struts, waterjets, pumps, controls, and main propulsion machinery in the ships of each participating nation were to be identical, both in equipment and arrangement. Additionally, the auxiliary equipment and arrangements, deckhouse, and personnel accommodations embodied a standard design. However, several variations in the latter were available to suit individual country manning requirements.[76]

An important element of the matrix study involved the selection of major subsystems; an exercise laden with political overtones, as national preferences

and the need to balance work sharing as much as possible among the three national industries, played themselves out.

a. The Standard Tri-national Propulsion Systems

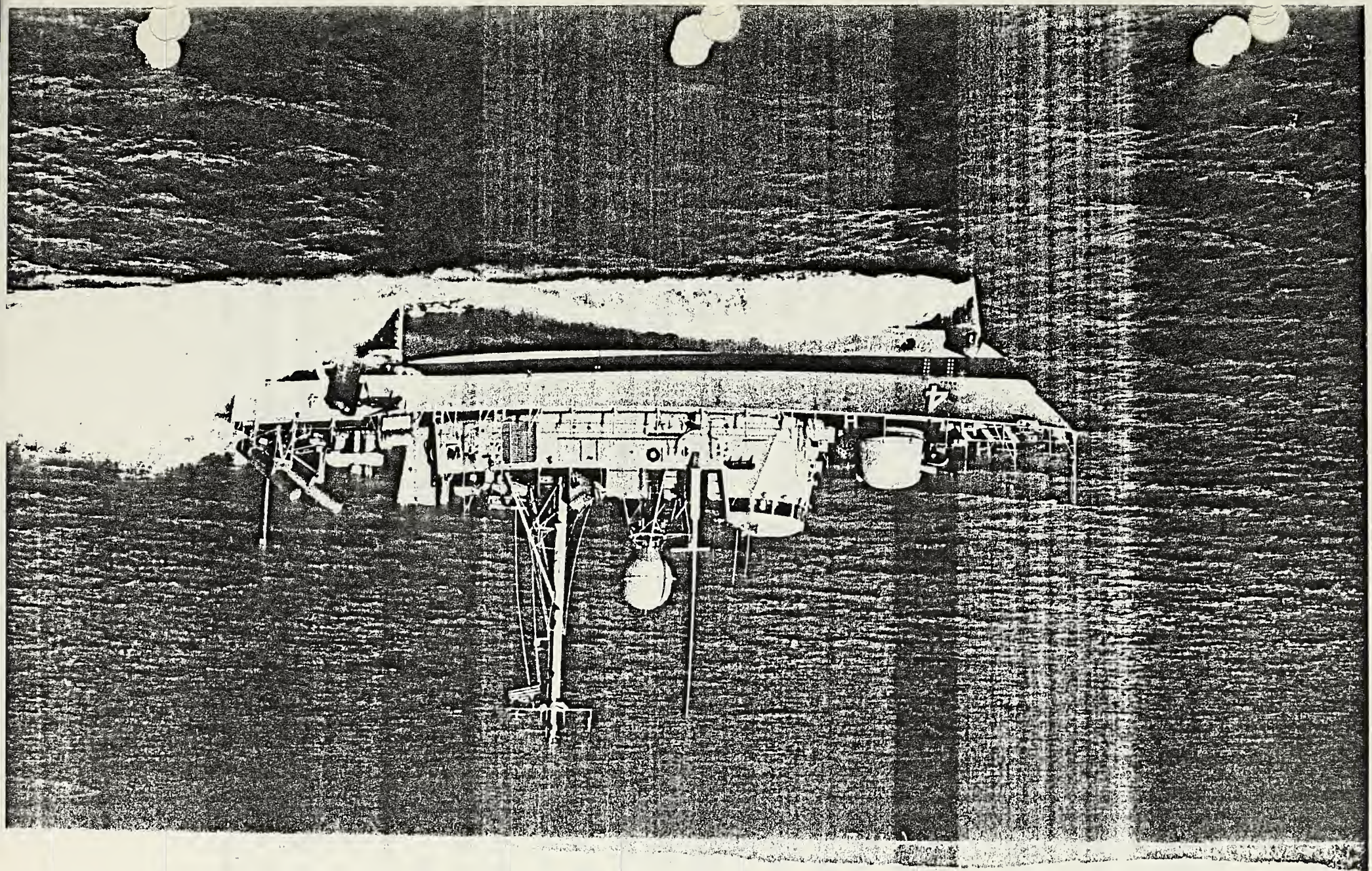
As stated above the main propulsion machinery is standard to all national variants of the PHM. It also included major work shares for the industries of all three participating nations. The PHM propulsion plant consists of two independent systems, separated from each other by watertight boundaries. The hull-borne system consists of two waterjet pumps, each driven by a Mercedes-Benz (later MTU) 8V331TC80 diesel engine. The foilborne system consists of a single waterjet pump driven through a power-splitting reduction gear by a General Electric LM 2500 gas turbine engine. An advantage of this arrange-ment is that the diesel provides economical, long-range cruising and close-in, slow-speed, twin engine maneuvering while the relatively lightweight gas turbine is immediately available for high-speed foil operation when required. Additionally, the redundancy of this arrangement enhances ship survivability in peacetime as well as wartime. The LM 2500 marine gas turbine is a 2-shaft, simple-cycle, high-efficiency engine, developed from the GE TF39 aircraft jet engine that powers the United States Air Force C-5A transport and McDonnell Douglas DC-10. Extensive modifications have made it suitable to the marine environment, and it is being employed in several other major U.S. Navy ship classes.[77] The LM 2500 on the PHM is a derated variant of that used on the larger U.S.N. ships and approximately one third of the content is Italian built.

b. The Standard Italian Gun

Whereas the U.S.N. was exploring the introduction of two foreign systems into its inventory on a large scale, the OTO Melara 76mm gun and the HSA fire control system (FCS), in parallel for both the planned 30 ship buy of PHM's, plus the FFG-7 frigates, the FRG was also looking at commonality considerations. The German Navy, however already had both systems in its inventory. The OTO Melara 76mm dual purpose gun was first introducted in the late-1960's in the 20 S-148 fast patrol boats.[78] The fire control system (FCS)on the S-148 was a Thomson-CSF Vega model. The OTO Melara gun was again adopted for the order of ten S-143 fast patrol boats several years later. The S-143 was designed and built by the AEG-Telefunken and Luerssen team. For the S-143 though, the HSA WM/27[79] FCS was chosen. The S-143 also carries torpedoes and Exocet anti-ship missiles. The second batch of ten S-143A's that were later ordered in lieu of S-162's were slightly different in that they had metal instead of wooden hulls, only one 76 mm gun and greater anti-aircraft capability.[80]

The Italian Navy had meanwhile also adopted the OTO Melara gun for its P-420 military hydrofoil, and several other surface combatants.

Not surprisingly, the Italian OTO Melara 76mm gun was the one eventually chosen in 1972 to be the standard primary gun for the PHM. It satisfied the requirements of all participating national variations. It represents a significant advance in lightweight, reliable design and performance over previous gun systems available for hydrofoil application. Except for two ammunition loaders, the gun is unmanned and automatically controlled by the fire control system, with the firing controls centralized at the weapons control console.



The ship can be delivered with or without secondary guns. If specified, two MK20 Rh 202 20mm AA guns can be provided, one each port and starboard, adjacent to the fire cotrol antenna structure. In addition, spaces are also available for pyrotechnics, small arms, and small arms ammunition.[81]

c. The National Variant Fire Control systems

The heart of the standard command, surveillance, and weapons control suit for both the German and U.S. variants is the WM-28 Radar and Weapon Control System developed by N.V. Hollandse Signallapparaten of the Netherlands (or its Americanized version, the MK 92). The WM/28 is a solid state system that offers one radar dish to do two jobs, both scanning and tracking. This fire control system embodies a combined fire control and search antenna system, mounted on a single stabilized platform and enclosed in a fibreglass radome. The system has a minimum surveillance range suitable for close range, precise navigation and a maximum range compatible with the employment of the ship's weapon suit to its full capability.[82]

Whether a common fire control system would have been established for all participating nations was never definitively determined. Other modern fire control systems can be installed such as the ARGO system, one of several considered by Italy for adoption.

It was actually the WM/25 that had orignally been considered by the USN for the PHM and FFG-7 program's but with the WM/28's appearance, the USN adopted the newer system. The HSA fire control system has evolved over the last two

decades from the WM/20 to: the WM/22 two of which were built under license by Speery for the USN and a derivative of which was built in Canada as the WM/26; the WM/25 which was originally considered for the PHM and interoperable with the NATO Seasparrow SAM system (and mated to it for the Dutch, Belgian and German Navies); and then finally the WM/28 which is now under construction in the U.S., and again by Sperry, as the MK 92 FCS.[83]

The essential features of the WM/28 system are a compact integrated design, resulting in minimum size and weight; extreme reliability, incorporating the latest solid state techniques and the use of integrated circuits and miniaturized electronic components; simplicity in operation; and, most important, short reaction time. These systems are particularly designed for use against surface-to-surface missiles, air-to-surface missiles, aircraft, and surface targets of all types as well as for direct or indirect bombardment of land targets. The fire control antenna is normally controlled automatically by the digital computer, but it can also be operated manually to search for targets if desired. When radar range is not available, as for example, when engaging indirect shore targets, target settings can be applied to the system manually from information supplied by the ship's combat information center. This method can also be used for ship targets in an emergency.[84]

Once a target has been acquired, missile and gun orders are automatically generated by the general purpose digital computer. Firing is by manual controls located on the weapons control consoles.

d. The National Variant Missile Systems

Since the participating nations indicated preference for their individual missile systems from the beginning, none has been designated or included in the Standard Ship. However, the flexibility of the PHM design permits the installation of a variety of surface-to-surface missile systems; including either: the USN/McDonnell Douglas Harpoon; the French Aerospatiale Exocet (chosen by the FRG); the Italian missiles, Otomat or Teseo; or any smaller missile system. Space has been provided on the fantail to accommodate missile launchers, port and starboard in parallel pairs, that are deck-fixed in elevation and azimuth. The space and weight allocation satisfied each presently identified national requirement.[85]

All necessary equipment for guidance of the missile will be engineered in combination with the WM28/MK 92 system. The missile checkout, firing, and guidance controls are centralized in the missile status and firing section of the weapons console. It is to be noted that neither launcher crew nor shipboard maintenance of missiles is required.

As the USN is the only nation to procure PHMs to date, the USN Harpoon is the only missile currently in use on PHMs. The Harpoon is designed to fly itself, homing in on radar beams that it bounces off the target ship. It flies low over the waves to make it hard to hit, gains altitude just prior to reaching the ship and drives a 500-pound warhead into the ship's vulnerable top decks.

8. Negotiation of the Design and Development Memorandum of Understanding

U.S. objectives in promoting allied participation in the PHM project were: reduce initial non-recurring costs to the U.S. involved in launching a project based heavily on U.S. technology and targeted for adoption by allied navies; obtain the downstream operational and economic advantages of standardization; and indulge in a little image building for NATO and the U.S. (very laudible aims). Now how does one get there given the numerous constraints?

First of all, in any such negotiation with potential partners, everyone is, at least initially, trying to get the most while giving the least. The thorniest problem to be faced during the MOU negotiations extending from mid 1971 to the fall of 1972 was basically over the conditions that would be attached to the release of the resultant technical data package (TDP).

Chief among these conditions would be work-sharing, i.e., the eventual arrangements that would be worked out for the subsequent production phase (as the developmental work sharing for this project would inevitably be unbalanced). The basic dilemma was simply , how could the release of the TDP be tied to conditions in the first design and development MOU, which inevitably had to remain vague with regards to the eventual distribution of production, while awaiting the completion of lead-ship development and the negotiation of a second more precise production stage MOU. In short, how to gain and maintain voluntary participation through balancing cost and benefits among all of the participants over time while simultaneously managing a rational allocation of the available resources to fulfill a common military requirement. No small feat.

Yet another ticklish aspect of the decision-making dynamics summarized above, centered on the U.S. Navy's having to oversee the completion of a feasibility/ matrix design study that reflected a concensus among a fluid set of partners, while avoiding seriously compromising the USN's ultimate determination of what it individually needed. Meanwhile, U.S. funds were being committed and spent covering the full cost of the design study (for eventual reimbursement if things went as planned). Naturally the U.S.N. could not accept a system that did not meet its requirements. As it turned out this didn't happen, though it could have been a serious problem.

Another dilemma faced by U.S. Navy negotiators was that, it would be necessary to separate the wheat from the chaff, i.e., identifying and negotiating with those among the 'interested' nations that were in the end likely to make firm com-mitments. Once a smaller grouping of engaged nations willing to make commitments was established, it could proceed with substantive negotiations. But this had to be accomplished in a manner that would keep the interested nations in the picture as observers as long as possible to avoid closing anyone out prematurely when 'only a little more time and information was needed'. This in turn suggests yet another issue, how much data actually needed to be disseminated in order to obtain and sustain this interest without compromising the interests of the originators of the data and the program's momentum. This naturally has to be accomplished with the full knowledge that most recipients primarily are interested in information gathering.

Yet another consideration involves the timeliness of decision making and commitments of each of the participating governments. The fumbling of any one of

them can waste vital weeks or even months for the other participants who can do little more than sit on their hands.

One last point closely interrelated with the previous one involves the multiple actors and corresponding coordination activities and influences impacting the national negotiating teams. The U.S.N. team had to coordinate with other components within the DoD, especially the OASD/ISA, and with other Government departments including the Treasury Department; and then there were the natural, low-level blue-suiter pressures associated with international navy-to-navy comraderie and the small close-knit hydrofoiler club which included the U.S. contractor. There were also those usual differences between the allied navies vis-a-vis government-contractor relations, involving, for example, the passing on of information on the status of government-to-government negotiations, representing the interests of their own industries, and attendance at contractor hosted social gatherings.

After the completion of the Tucumcari demonstration in Northern Europe the prospects for a joint project rapidly improved. One month later, in June the U.S. negotiating team was formed at the insistance of the office of the Chief of Naval Operations (CNO). The office of the CNO was responsible for all negotiations with allied navies. For the PHM project the task fell to the Deputy Chief of Naval Operations for Surface Warfare (OP-37), Admiral Halverson. OP-37 provided overall policy guidance through the heading up of U.S. representation to the NATO Project Group 6 and later to the Project Steering Committee. Limiting its role to one of providing sponsorship and direction, OP-37 received support at the working level in technical and acquisition matters from NAVSHIPS (later consolidated with NAVORD (ordnance) into NAVSEA).

The NAVSHIPS Deputy Counsel for Procurement at the time was Mr. Peniel Moed, who was brought in to provide legal support. Though nothing formal, as negotiations progressed Mr. Moed's role gradually expanded from a procurement support function to one of spokesman for U.S. positions in negotiating the MOU. Later, once the MOU was signed, Mr. Moed continued to serve as (among other responsibilities) Counsel to the Project Office up through December 1976. Prior to leaving NAVSEA in 1976 Mr. Moed spent three additional years (early 1973 to early 1976) negotiating the never to be signed PHM Production Stage Supplement to the MOU.

The first Project Group 6 meeting dealing with the prospective MOU for a joint design study was held in London in June 14-16, 1971. The U.S.N immediately assumed the lead in drafting the MOU. Following this meeting, Mr. Moed produced the first of six draft agreements (the last of which was ultimately signed in November 1972, thus becoming the MOU). All PG-6 countries intending to participate had to submit written comments on the U.S. draft by July 15. After this, the next milestone was August 2, when a one page letter of intent was due from each country intending to commit resources. Following subsequent meetings of PG-6, and then the project Steering Committee after January 1972, Mr. Moed would re-draft the MOU, then circulate it within NAVSEA and OP-37, and finally to the allied teams participating. Wording was generally not negotiated at the table due to language problems. The negotiations tended to be conceptual.

The U.S. Navy team used the NATO Seasparrow developmental stage MOU as the principal model for the NATO PHM project. The carry-over from NATO Seasparrow

was especially noticeable in the areas of the ultimate MOU dealing with patents and technical data. But one could only go so far on this basis, since many areas of the provisions were uniquely the product of the NATO Seasparrow negotiations and were inapplicable to NATO PHM.

Through the summer of 1971 and into the fall, most nations on PG-6 gradually dropped away as the U.S., the FRG and Italy reached a concensus on the basis upon which a joint project would be launched. Letters of intent were signed shortly thereafter. First the Portugese and Turks dropped out, joining the French and Dutch in the status of observers, then the Canadians, Norwegians, Danish and finally the British became observers. The last Navy to go in late 1971, the British, presented a particular challenge. It became increasingly doubtful that they would ever be able to come up with the money to join, their interest in the fine points of language and other details of the negotiations continued. The intensity was there, but not the money. Detailed and binding negotiations must be avoided until the serious players are on board.

Gene Myers, Boeing PHM Program Manager (November 1971 to August 1973), observing these negotiations from the sidelines, felt strongly that, among all the observer nations, it was the Danish Navy that had the most earnest interest in the project, and came the closest to being the fourth participant.

As previously mentioned, the most difficult issue througout the negotiations concerned the technical data package (TDP) and the conditions attached to its eventual utilization by the Italians and Germans. There was a concern on the part of the U.S. Navy that Italy might ultimately be forced to pull out without

ever building ships for its own use, after it had received the TDP. There was a need to make a clear linkage between construction for a nation's own use, i.e., for NATO purposes first, and then later maybe develop foreign sales as an ancillary effort to help amortize non-recurring costs associated with the set up of the specifically NATO production effort.

Including prior efforts in the area of hydrofoils, the U.S.N. was providing 100% of the original system unique technology[86] while initially offering to split the non-recurring costs of this project on an equal basis, i.e. 1/3 for each nation. For the two European participants, the TDP for an extremely unique and advanced system was to be made available on a royalty free-basis (at least as far as their own ships were concerned) in return for a limited investment. In order to attain U.S. Government objectives for the project, i.e., procurement and deployment of the ships by as many NATO Navies as possible, it was important to structure the MOU so that the U.S.N. maintained enough leverage to keep the allies on board after they started receiving the evolving TDP. The final conditions agreed to are covered in the next section. Simply put, if they procured one lead-ship in the U.S. and/or if they first procured PHM's for their own navies, they could utilize the TDP sooner for foreign sales.

The Italians found the conditions calling for procurement for their own Navy first, hard to swallow, though this was not a problem for the Germans. The latter were less sales oriented. The building of one lead-ship in the U.S. first was even more ticklish, again especially for the Italian Government.

The interests of the U.S. contractor, Boeing, had to be protected as well. However Boeing's precise intentions were never known by the U.S. negotiators, as it was felt that it would have been inappropriate to consult with them at the time (contrary to the situation in the other two countries where there was close coordination)—a yet unsolved dilemma for the U.S. Government in all such interallied negotiations.

Another area where considerable time was eaten up was the definition of shared and non-shared costs.

Here too, the original model was adopted from that of the NATO Seasparrow, though they evolved differently. In the end it was simply impossible to anticipate all cost categories, and there were the inevitable querks for the ones that were anticipated.

As the European involvement in such efforts has stronger political and less of a technocratic overtone than for the U.S. participants, they had to be able to justify how every cent would be spent for their own budgetary battles back home. Of course in the end with the NATO PHM project, with the cost explosion that begain in 1973, whichever way it was split, cost was not a nickle and dime
issue.

Another delicate matter in such negotiations is the extent to which the observer nations were to be kept informed. With the British, the Canadians, the Danes and others on the side lines, i.e., continuing to send observers to PG-6, it

was always a question of how much they were entitled or needed to know. While the three engaged nations wanted to keep the others interested, it had to be made clear that their would be no free rides. A minor complication involved France, who was an observer from the beginning on PG-6 (and therefore never involved in the negotiations). At those formal PG-6 meetings where they were present the French insisted on dual translation into French, as it was NATO's other official language.

Another problem that arose during negotiations, was the turn-around time on obtaining commitments. It took a substantially longer amount of time to get signatures for Italy.[87]

Inter- and intra-agency coordination problems also cropped up. For starters, the general work-sharing formula for the design and development MOU was intentionally vague, while the U.S. Navy and prime contractor were trying to line up mutually acceptable work packages for the other governments, first for the lead-ship component systems and later for license production. The U.S.N. and the contractor were finding it rough going in comparison with work distribution on the NATO Seasparrow. At the time when the Navy finally felt that one of its major lead-ship work packages, the 76mm OTO Melara cannon was locked up as an offset to Italy for the PHM, they discovered that through an oversight the item had also been under negotiation with the Italian Government as an offset in connection with an Italian purchase of another U.S. weapon system.

In a later case, during negotiations in 1974 and 1975 for the Production Stage Supplement, another inter-agency offset problem appeared. Though satisfactory

production sharing and offset arrangements had been attained for the Italians (even though they were to drop out later in 1974 for a mix of other reasons), problems were still being encountered with the Germans. The Germans had accepted that one lead-ship would be built in the U.S. However, German ship-building was now in need of work and the German negotiator needed politically acceptable answers for the Bundestag's Defense Committee. The FRG wanted the ship on the U.S-German troop offset shopping list. This was a separate higher level offset framework which was the domain of the U.S. Treasury Department and the OASD/ISA. The U.S. negotiators resisted this proposal as being beyond their authority.

Another problem area surfaced over provisions negotiated on establishing a trust fund for which interest would be paid on payments made by the non-U.S. participants until expenditures were made. Though not pleased with the arrangement, the Treasury agreed to set up trust accounts because commitments had already been made.

9. The Memorandum of Understanding (MOU)

a. The PHM Project and NATO

Quoting from Section I of the MOU:

> The Signatory Governments (hereinafter referred to as the Participating Governments), as a result of exchanging views under the provisions of North Atlantic Treaty Organization (NATO) Document C-M(66)33 (2nd Revised) of 8 January 1969 and the approval of the NATO Naval Armaments Group (NNAG) of the recommendations of the NATO Project Group 6 (PG-6) have decided to participate for defense purposes in a cooperative project initially for the design and subsequently for the production of a NATO Hydrofoil Fast Patrol Ship, Guided Missile (hereinafter referred to as the "NATO PHM Ship").
>
> The cooperative project is intended to proceed to two stages which are the Design Stage and the Production Stage. This Memorandum and its attached Schedule "A" and Annex I state the terms for the conduct of the Design Stage and contains provisions with respect to the initiation and conduct of the Production Stage. It is intended, however, that commitments of Participating Governments to participate in the Production Stage will be undertaken upon their respective evaluation, approval and signature of a later Production Stage Supplement to this Memorandum.
>
> The Participating Governments will request the NATO Conference of National Armaments Directors (CNAD) to endorse this cooperative project as a "NATO Project."

In addition, as spelled out in Section VII of the MOU, the NATO Patrol Hydrofoil Project Steering Committee (NPHPSC) was to provide, annually, a report of the progress of the NATO Patrol Hydrofoil Project to the NATO Conference of National Armaments Directors (CNAD). Supplementary information could be provided to other NATO member nations as may, during the course of the cooperative project, be accorded the status of observer.

b. An Outline of the 40 page MOU

SECTION I - INTRODUCTION

SECTION II - OBJECTIVES AND SCHEDULE OF THE DESIGN STAGE

a. Objectives
b. Schedule

SECTION III - PERFORMANCE OF THE NATO PHM SHIP DESIGN

a. Definitions
b. Accomplishment of the NATO PHM Ship Standard Design
c. Accomplishment of the NATO PHM Ship Variation Designs
d. Measurement System
e. Acceptance of Ship Production Data Packages

SECTION IV - MANAGEMENT OF THE DESIGN STAGE

a. The NATO Patrol Hydrofoil Project Steering Committee (NPHPSC)
b. NPHPSC - Rules and Chairmanship
c. NPHPSC Matters Requiring Unanimous Votes
d. NPHPSC Matters Requiring Majority Votes
e. Matters Pertaining to NATO PHM Ship Variation Designs
f. The NATO Patrol Hydrofoil Project Office (NPHPO)
g. Responsibilities of the Project Manager

SECTION V - FINANCE AND COMMITMENTS RELATING TO THE ACCOMPLISHMENT OF THE NATO PHM SHIP DESIGN

a. NATO PHM Design Shared Costs
b. Methods of Sharing Design Shared Costs
c. NATO PHM Design Individual Costs
d. Revision and Updating of Cost Estimates
e. Arrangements for Financial Adjustments
f. Financial Records
g. Payments
h. Costs Incurred by the Government of the United States of America Prior to Entry into Effect of this Memorandum of Understanding

SECTION VI - THE PRODUCTION STAGE

a. Objectives
b. The Production Stage Supplement
c. Principles to be Reflected in the Production Stage Supplement
d. Balance of Payments
e. Verification of NATO PHM Ship Production Data Packages
f. The Steering Committee

SECTION VII - REPORTS

SECTION VIII - EXCHANGE OF TECHNICAL INFORMATION AND USER RIGHTS

a. Definitions
b. Foreground Information-Disclosure
c. Foreground Information-Use
d. Background Information-Disclosure
e. Background Information-Use
f. Filing of Patent Applications
g. Protection of Owner's Rights
h. Proprietory and Manufacturing Rights
i. Delivery of NATO PHM Ship Production Data Packages and Exercise of User Rights
j. Recoupment of Design Shared Costs

SECTION IX - VISITS TO ESTABLISHMENTS

SECTION X - PROVISION OF ADDITIONAL MATERIAL

SECTION XI - SECURITY

SECTION XII - SALES AND TRANSFERS

SECTION XIII - PARTICIPATION OF ADDITIONAL GOVERNMENTS

SECTION XIV - CONTRACT PROVISIONS RELATING TO THE ACCOMPLISHMENT OF THE NATO PHM SHIP DESIGN

a. Placement of the Design Stage Prime Contract
b. Provisions to be Inserted in the Design Stage Prime Contract
c. Requirements to be Included in the Design Stage Prime Contract
d. Subcontract Assistance
e. Copies of Contracts

SECTION XV - TERMINATION OF PARTICIPATION IN THE DESIGN STAGE

a. Preface
b. Unilateral Termination of Participation in the Design Stage
c. Multilateral Termination of the Design Stage
d. Rights and Licenses in Respect of Technical Information
e. Continuation of Work After Termination
f. Discontinuance of a NATO PHM Ship Variation Design
g. Security Measures

SECTION XVI - TAXES, DUTIES AND OTHER CHARGES

SECTION XVII - EFFECTIVE DATE OF THE MEMORANDUM OF UNDERSTANDING

ANNEX I - Circular of Requirements for System Design and Construction Planning of the NATO PHM dated 15 October 1971, (and 22 October 1971 NATO PG-6 Initial Revisions, 17 December 1971 NATO PG-6 Second Revisions).

SCHEDULE A - NATO PHM Design Shared Costs - Initial Estimates, Shares, and Payment Schedule

c. Organization

As spelled out in the MOU, a NATO Patrol Hydrofoil Project Steering Committee (NPHPSC) was to be responsible for the implementation of the Design Stage within the terms of this Memorandum of Understanding. The NPHPSC was composed of one member from each of the Participating Governments. Each member of the NPHPSC was responsible for the necessary coordination with the appropriate authorities of his own country.

The NPHPSC promulgated its own rules consistent with the terms of this Memorandum for the conduct of its business and the performance of its responsibilities. The chairman of the NPHPSC was to initially be the U.S. member with the proviso that the NPHPSC would establish its own procedures for the selection of successor chairmen.[88]

Decisions of the NPHPSC on the subjects set forth below, per Section IV of the MOU, were to be made by unanimous vote.

- Questions concerning the allocation of costs between Shared and Individual Costs for the design stage.
- Questions concerning the allocation of costs as between NATO PHM Design Costs (both Shared and Individual Costs) and NATO PHM (U.S. Lead Ships) Construction Costs.
- Approval of revised and updated Shared Design Costs Estimates.

- Approval of revisions and supplements of the Circular of Requirements insofar as they relate to, or substantially affect, elements of the NATO PHM Ship Standard Design.
- Approval of the Design Stage Prime Contract.
- Approval and authorization of acceptance of the technical information constituting the NATO PHM Ship Standard Design.
- The numbers and specialties of staff personnel to be furnished by the Participating Governments for service in the NATO Patrol Hydrofoil Project Office.
- Any other matters which are stated in an adopted rule of the NPHPSC as requiring its unanimous decision.

All other decisions of the NPHPSC pertaining to the accomplishment of the Design Stage were to be made by majority vote of all members.

The organization, mode of operation, duties and responsibilities of the Project Office were established by the NPHPSC.

The NPHPSC established the NPHPO to serve as its executive staff. THe NPHPO was to be headed by a Project Manager designated by the U.S. Government. The NPHPO was to be located in the Washington, D.C. area. The NPHPO staff was to be the minimum size recommended by the Project Manager, and approved by the NPHPSC, to be necessary for successful administration and operation of the Design Stage. The Participating Governments were to furnish staff personnel for the NPHPO in the numbers and specialties recommended by the Project Manager and unanimously approved by the NPHPSC.

The Project Manager was to be responsible for the management of the activities of the Project Office, consistent with assignments and directions of the NPHPSC and with the Memorandum of Understanding.

d. Joint Funding Arrangements

Per Section V of the MOU, those costs which would be shared between the Participating Governments were:

- The costs of work performed pursuant to the Design Stage Prime Contract in order to accomplish the NATO PHM Ship Standard Design.

- The costs of tests, trials, and evaluations conducted with any Lead NATO PHM Ship or Ships for the primary purpose of demonstrating and proving the NATO PHM Ship Standard Design.

- The costs of operating the NATO Project Steering Committee and the NATO Project Office.

- The costs of maintaining clerical and secretarial staff of the NATO Project Office.

- The costs of certain work performed in Government operated or controlled facilities as determined by the NPHPSC.

The Participating Governments shared the 'NATO PHM Design Shared Costs' on the following basis:

- The Design Shared Costs incurred for the accomplishment of Subphase I (Preliminary Design) were to be equally shared; and

- The Design Shared Costs incurred for the accomplishment of Subphase II (Production Design) will be shared as follows:

  - Twenty-five percent (25%) of the amounts of such Design Shared Costs will be equally shared; and

  - Seventy-five percent (75%) of such Design Shared Costs will be shared pro rata on a 2:1:1 basis between the U.S., the FRG, and Italy.

As the MOU further stated in Section V, it was intended that the Participating Governments' respective shares of Pro Rata Shared Costs would be redetermined through mutual agreement of the Participating Governments. Such redetermination would be initially made on the fifth anniversary of the delivery of the first NATO PHM Lead Ship of the U.S., and would be subsequently and definitively made as of the tenth anniversary of such delivery. One of the factors to be given weight in establishing such redetermined shares was to be the quantity of NATO PHM ships and other naval combatant hydrofoil ships essentially similar to the NATO PHM Ship Standard Design which have been delivered, are under construction, or are under firm order as of the pertinent anniversery date by, to, or for the individual Participating Governments for their respective defense purposes and defense sales. Payments and refunds resulting from redeterminations were thereafter to be effected between the Participating Governments as soon as possible.

By way of a recovery of the NATO PHM Design Shared Costs, each Participating Government is to arrange for the imposition of a levy on its defense sales made prior to the date, specified in Section V, as of which the shares of pro rata Shared Costs to be borne by each of the Participating Governments is to be finally redetermined. The rate of such levy is to fixed by the NATO Project Steering Committee prior to the completion of the Design Stage. All levies so recovered would be divided among the Participating Governments at the time of the redeterminations.

The NATO PHM Design Shared Costs did not include the following costs:

- The costs of maintaining the individual members of the NATO Project Steering Committee and the Participating Governments' personnel on the NATO Project Office staff, including their communication and travel costs.

- The costs of the work required to be performed to accomplish each of the NATO PHM Ship Variation Designs.

- The provision of additional material.

- The total costs for and relating to the construction of the NATO PHM Lead Ships of the U.S., including the costs of installed equipments and of construction administration. The foregoing costs were referred to in this Memorandum as "NATO PHM (U.S. Lead Ships) Construction Costs," which were, except for the portion thereof which constitute NATO PHM Design Shared Costs, to be borne entirely by the U.S.

Per Schedule A, attached to the MOU, Participating Governments' Shares of Initial Estimate of Total NATO PHM Design Shared Costs were to be:

Federal Republic of Germany:			
Subphase I	-	$ 2,870,000	
Subphase II	-	6,310,000	
			$ 9,180,000
Italy:			
Subphase I	-	$ 2,870,000	
Subphase II	-	6,310,000	
			$ 9,180,000
United States of America:			
Subphase I	-	$ 2,870,000	
Subphase II	-	10,680,000	
			$13,550,000[89]
Initial Estimate of Total	-		$31,910,000

The Schedule of Payments by Participating Governments of Shares of Initial Estimate of Total NATO PHM Design Shared Costs into the projects trust fund was to be as follows:

PAYMENT DATE	FEDERAL REPUBLIC OF GERMANY PAYMENTS	GOVERNMENT OF ITALY PAYMENTS	UNITED STATES OF AMERICA PAYMENTS
First Payment (see note 1)	$6,690,000	$6,690,000	$ 9,330,000
31 July 1973	950,000	950,000	1,610,000
31 January 1974	1,230,000	1,230,000	2,090,000
31 July 1974	310,000	310,000	520,000
Totals	$9,180,000	$9,180,000	$13,550,000

e. Work Sharing Arrangements

Although there were no fixed work-sharing objectives spelled out in either the MOU or the NAVSHIPS contract to Boeing, the following work-sharing objectives for the Design Stage were summarized in general terms in Section II of the MOU:

> Utilize most effectively the military, industrial, scientific and technical resources of the Participating countries, in terms of both men and material in the interest of the cooperative project.
>
> Maximize the scope of the NATO PHM Ship Standard Design, and of commonality of equipments and materials included therein, in order to increase the opportunities for economical production and subsequent coordinated logistic support for the Ships among the Participating Governments in furtherance of their mutual defense.
>
> Ensure that products of national industries of the Participating Governments are given full and thorough consideration in the selection of equipments and material to be incorporated in the NATO PHM Ship Standard Design and NATO PHM Ship Variation Designs.[90]

Consultations were to be held among the Participating Governments in order to arrive at agreed terms for conducting the Production Stage. These terms were to be set forth in a Production Stage Supplement to this Memorandum.

Per Section VI of the Design and Development MOU, each Participating Government intended to have constructed in the U.S. at least one NATO PHM Ship.

As spelled out in the Design and Development MOU certain principles were to be reflected in the terms of the later production stage MOU:

- NATO PHM Lead Ships (other than PHM-1 and PHM-2) were to be placed by the U.S. Government on behalf of, and with the advice and approval of, each respective Government. These contracts were to be placed with the firm which had performed the Design Stage Prime Contract unless any member of the NPHPSC considered that negotiations had not resulted in acceptable terms, in which case the Steering Committee would direct the Project Manager to proceed with a competitive procurement.

- The U.S. Government was to make available such inspection and construction administration services at the respective construction sites in the U.S. and would be reimbursed for such services in the amount to be agreed in the Production Stage Supplement.

- Each Production Participation Government would bear the entire cost fixed in its NATO PHM Lead Ship Construction Contract and a portion of the costs of conducting the Production Stage in a ratio to be established in the Production Stage Supplement.

- Balance of payments problems of the Production Participation Governments were to be minimized by requiring the placement of contracts and purchases among them in an agreed ratio which would equalize expenditures among these countries to greatest extent feasible consistent with established ship requirements. The ratios material and services to be supplied in furtherance of Balance of Payments equalization were to be established later in the Production Stage Supplement.

Under Section XVI of the MOU, duty-free entry was assured for all technical documents and hardware into participating countries necessary for the accomplishment of the Design Stage of this project (except dues and taxes which are no more than charges for services rendered).

The NATO PHM Ship Production Data Packages were to be promptly delivered to the Participating Governments for informational purposes to enable necessary preparation for national production to be commenced.

However rights of use of the contents of the NATO PHM Ship Production Data Packages granted pursuant to this Section would be exercisable only under certain stipulations.

Participating Government placing a NATO PHM Lead Ship Construction Contract with the U.S. contractor could use it:

- For defense purposes - immediately after placement of the said Contract.

- For defense sales - three (3) years after delivery of the first NATO PHM Lead Ship or one (1) year after delivery of that Participating Government's NATO PHM Lead Ship pursuant to its NATO PHM Lead Ship Construction Contract, whichever event occurs first.

While a Participating Government not placing a NATO PHM Lead Ship Construction Contract with the U.S. contractor could make use of it:

- For defense purposes - two (2) years after delivery of the first NATO PHM Lead Ship.

- For defense sales - five (5) years after delivery of the first NATO PHM Lead Ship.

10. Disruption and the NATO Program's Collapse

a. Major Milestones: 1974-77

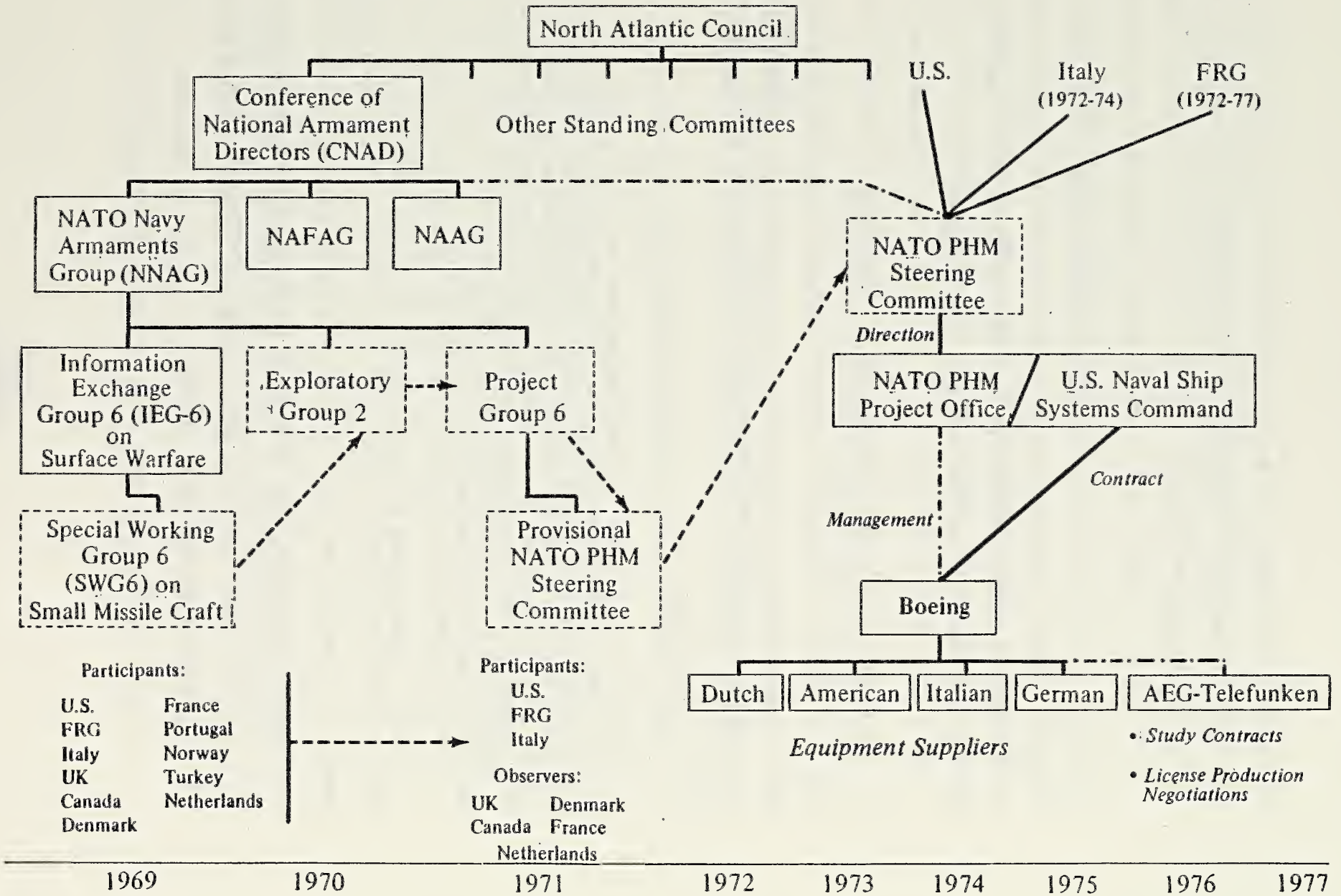
A 243.5 ton PHM-1 was launched, fully combat outfitted, in mid-1974. The ship's weight had since increased by another 18.5 tons in an effort to make it more producible and increase the fatigue life of the foils and struts. However, in August 1974, work was suspended on PHM-2 due to rising costs.

Later that year Italy, which had become increasingly uncomfortable over the complexity and size of the system, was forced to drop out of the project. This was due to not only the cost problems encountered on the program, but the more immediate funding problems emanating from the oil crisis and the concommitant drop in the value of the Lira.

Due to cost increases, in FY1975, the U.S.N.'s total long-lead planning figures reduced the program from 30 ships down to 24 ships while funding the construction of first four production ships. In FY1976, with the post-Zumwalt era setting in, the total for long-lead planning purposes dropped to six ships, with funding again being provided for the four production ships, plus completion of PHM-2.

After successful completion of Operational Evaluation (OPEVAL) in June 1976, the Pegasus was returned to Seattle and commenced in September an eight month major overhaul and OPEVAL deficiencies correction period. In early June, 1977 the ship conducted its Acceptance Trials, and was cited by the President, Board

NATO Patrol Hydrofoil Missile (PHM) Project



of Inspection and Survey, for having presented one of the finest trials "in the memory of the Board." The Pegasus was delivered on June 15, 1977, and commissioned on July 9, 1977.[91]

On October 20, 1977, the Naval Sea Systems Command signed a fixed price incentive contract with Boeing Marine Systems for five PHM production ships to be delivered in Seattle between February 1981 and March 1982. Meanwhile the FRG had also withdrawn from the project. What happened?

b. Negotiation of the Production Supplement to the MOU

Well for starters, during 1973, after the lead-ship design and construction MOU had been signed late in the previous year, negotiations on the Production Supplement[92] continued at a vigorous pace, but the time horizon began moving out into the future.

As its urgency slipped, working on the Production Supplement became more of an obligatory exercise. But per the MOU, it had to be worked on. Starting in 1973, technical, cost and work sharing problems came to the fore. Cost, in particular, began to alarm the Italians and Germans.

There was also considerable concern over the efforts to find adequate foreign sources. As the cost and quantities of ships to be procured for each nation were changing, where the ships were to be built and what the percentage of their national content would be, took on added significance. The production sharing issues became especially difficult.

Another issue that came into play involved configuration control. How were the three to maintain a standard ship design. This had been easy to gloss over earlier, but once looking at production, this was clearly more difficult. This in turn raised logistic support problems.

On the latter point, there were a number of briefings by NAMSA. Germans and Italians did not strongly support utilization of NAMSA, but did generally favor it. On the other hand, the U.S. Navy took a firm position on it being a less rational approach than building-up on the existing U.S.N. system.

c. Cost Problems

The program began to incur serious cost growth problems starting in 1973.

First of all there were serious manning problems. Boeing's hydrofoil work over the previous 12 years had been accomplished by a small core of hydrofoil engineers working in an isolated skunk works atmosphere isolated from the highly developed aerospace engineering and manufacturing system throughout this period. When it came time to cash in on Boeing's pain stakingly acquired pre-eminence in this aerospace frontier, Boeing had only 19 hydrofoil engineers available. Given this limited base, following contract award the program began a rapid build up to

200 engineers in the first two months of 1972.[93] Exacerbating this problem, Boeing had meanwhile decided to simultaneously launch its commercial Jetfoil program. Three weeks into the PHM project, 10 of the 19 hydrofoilers were split off and assigned to the Jetfoil program.These people were thoroughly

initiated into the occult world of hydrofoils, having won three of the five contract awards made by the U.S.N. for experimental hydrofoil prototypes.

Here the first problems materialized and the ascent began toward ever accelerating cost. The compounding rate for the NATO PHM engineering staff over the two month period was 22 to 1. Overconfidence appears to have led to an ignoring of the compounding rate problem.

Though the matrix design study phase I was completed within cost, latent plans yet to be perform were to contribute in part to cost increases downstream. Furthermore, the USN abandoned its original concept of an expendible or 'throw-away' ship, in favor of one that was fully redundant. In the end, both Boeing and NAVSEA were responsible for developing what in some quarters was felt to be an over-specified system with excessive redundancy.

For its part, once it had placed the sole source contract, the U.S. Government did not intervene when as the contractor's limited resources began to be diluted by the simultaneous launching of the two hydrofoil programs. In hind-sight, the U.S. Navy should have forced a recompetition, as they did with the NATO Seasparrow project when an unacceptable proposal was generated by the sole source U.S. lead contractor, Raytheon (Raytheon won the competition with 13 other U.S firms anyway, but the net result was a much tighter design and cost proposal). Or the Navy should have at least put pressure on the PHM contractor until the situation was rectified.

Moreover, given the U.S. defense contracting environment where competitive pressures are being applied across the board for a number of projects, a defense contractor's priorities and resource allocation for a sole source proposal is bound to be unfavorably impacted.

European management on the other hand, is used to operating in a sole source environment where defense contractors are designated early-on (as the FRG and Italy basically did with Boeing). This results in yet another example of the difficulty of finding a good fit for any given defense project between the differing European and U.S. approaches to source selection.

One additional problem contributing to redundancy and over complexity that was reminiscent of the joint German-U.S. tank project, the MBT-70 (1963-1970), was that in certain areas of the design an either-or decision was never made where the U.S. and German Navy positions were incompatible. Consequently, the Project Office tended to keep both. This was particularly problematic in the area of electrical power.

In any event, under Zumwalt (CNO from 1970-1974) the original concept was 3 PHM's for the price of one FFG-7 class frigate. The PHM/FFG-7 ratio, remained at 3 PHM's for the cost of one FFG-7. However, with the PHM cost increase, critics of the PHM (and the conceptual reorientation the system represented for U.S. Navy thinking) in the DoD and Congress chose to focus on the trebling of the cost in absolute terms.

d. Tergiversation within the U.S. Government

Subsequent to successful completion of OPEVAL in June 1976, another set of problems began for the down scaled U.S.N. program. The project found itself being subjected to frequent reviews at nearly all levels of the government. These reviews involved such issues as technical risk assessment, component design improvement, independent assessment of performance and operational utility of the ship, production methodology, and cost. The Project Manager found himself having to deal with a series of nearly continuous reviews, each in turn generating unpredictable decisions and impacting on the progress of the program. These unprogrammed activities became increasingly serious during the spring of 1976, with Congressional committee action being taken to delete production PHM ships from the FY 1977 budget. Strong Navy and DoD appeal action, however, with the support of the Senate Appropriations Committee, resulted in Joint Conference Committee action to restore the funds.[94]

Throughout the fall of 1976 various reviews through the Navy and the DoD had progressed to a favorable DSARC III decision by the end of the year, and finally on January 10, 1977, the Deputy Secretary of Defense advised the Secretary of the Navy that the PHM production could proceed.

However, ten days later on January 20, 1977, the Administration changed and DoD priorities were reexamined. In February, 1977 the new President's FY 1978 budget revisions included language indicating deletion of the PHM's, and in April, a memorandum from the Secretary of Defense, Harold Brown, confirmed that decision. It appeared that the PHM project would finally follow the path of the two previous German-American joint design and development projects, the

MBT-70 and the AVS fighter.[95] Once again the European stereotype of the U.S. being an unreliable development partner was reinforced. In May, 1977, as required by the Budget and Impoundment Control Act of 1974, the President submitted a recission proposal to the Congress. After the Defense Subcommittee of the House Appropriations Committee held hearings on the subject on July, 12, the Subcommittee voted against the recission. With the Senate taking no action at all, at the end of 45 days the administration was obliged to proceed with the program.

Consequently, the Secretary of Defense released the appropriated funds and placed the program back into an authorized mode, and Boeing received the $178 million award for the production of 5 PHM's[96] in October, 1977.[97] By this time the total award to Boeing for the five production series ships came to $230 million. The six PHM's are all that remains of an originally planned 30-ship U.S. production run.

e. The FRG Withdraws

By the time Congress had completed its 1977 action refusing to rescind prior year appropriated PHM funding, the FRG was no longer an active production partner, and the dramatic unit cost reductions expected from a larger production base were lost.

Meanwhile, the FRG still had been committed to buying 10 PHM's into mid-1977 (9 through licensed production), but the funds were never authorized by the Bundestag. As stated in the June 1978 issue of Naval Engineers Journal, entitled, "The PHM—Surface Warfare Ship Technology Takes a Step Forward," by

Joseph N. Schrader and Cdr. Karl M. Duff, USN, "the decisions of the NATO partners not to enter coproduction probably had no direct effect on the U.S. program decision. However, an earlier positive decision on the part of either of the other two design partners might have favorably influenced the U.S. decision making process and the reverse would also have been true in the case of an FRG decision."[98]

In commenting further on the effects of the U.S. decision making process on the NATO PHM program, Schrader and Duff wrote:

> The sudden and extreme changes in the U.S. Government's position regarding production of PHMs for the Navy has had a decidedly negative effect on the continued program participation of the Federal Republic of Germany. As early as Spring of 1976, with the tentative moves by the Congress to delete four of the five production ships from the program, FRG representatives emphasized the delicate nature of their own program budgeting and decision making process and the importance of some positive program projections by the U.S. Navy.[99]

Although the United States did not enter into an active campaign to promote German commitment into co-production, later restoration of the production funding by the Congress in response to strong CNO and SEC-NAV positions in support of PHM production appeared to sustain satisfactorily the concurrent FRG program decision making process. However, with the announcement and personal communication to the FRG in January-February 1977 by the new Secretary of Defense, Harold Brown, that the United States was terminating its PHM Program and abandoning any further interest in production of PHM ships, the damage became essentially irreversible.

By the time Congress had salvaged the project, certain events had already been set in motion on the other side of the Atlantic. The FRG decided instead to:

- procure 10 more of their own conventional ships, the S-143A;

- terminate further participatory effort in the production design (which came to another $70 million) and meant that the data package possessed by the FRG is only that of the lead ship (the PHM-1 Pegasus) not that of the USN production series PHM's and;

- to bring home their Project Office personnel.[100]

f. Commentary

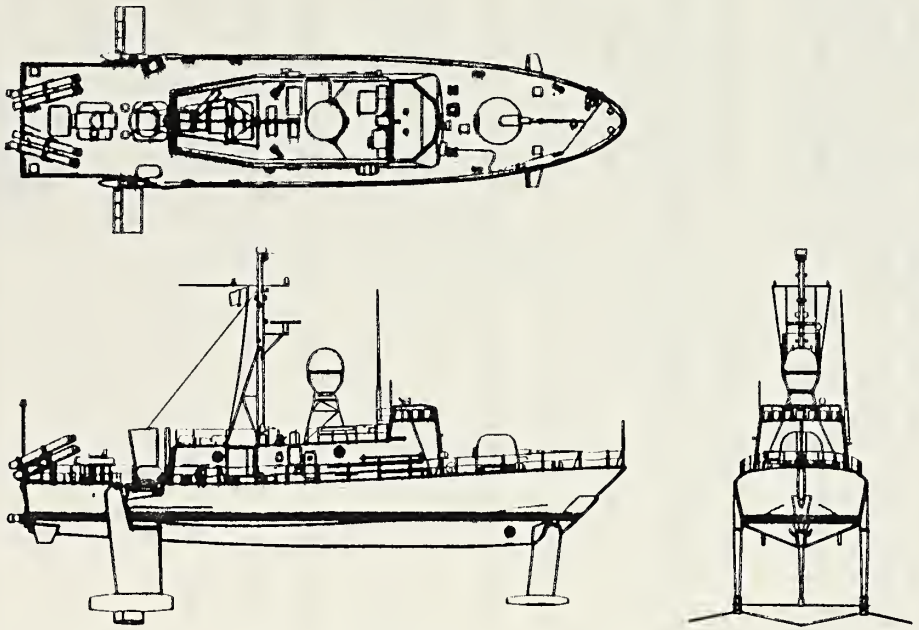
The Congressional battle in favor of the PHM had been led in the House of Representatives by Washington's Norm Dicks and in the Senate by the chairman of the Senate Appropriations Committee, Washington Senator, Warren Magnuson. Dicks went before the House Appropriations Committee in 1977 to urge Congress to overturn President Carter's decision to cancel the boats. "As you know, I have a somewhat parochial interest in this matter," he told his colleagues, but then said, "I'm not here to defend the contractor or the increased cost of this program."

Speaking some five years later, in March 1982, in regards to the Navy's not having yet decided upon a mission for the six-ship PHM squadron, Congressman Norm Dicks, said, "The Navy is resistant to change and is just being stubborn about the hydrofoils." Dicks, a strong supporter of the hydrofoil program said Congress may have to hold the Navy's "feet to the fire" to get it to try other uses for the boats.

PHM

PRINCIPAL DIMENSIONS

Overall hull length, foils down	40.5 meters
Overall length, foils up	44.7 meters
Hull length, waterline	36.0 meters
Aft foil span	14.5 meters
Hull beam	8.6 meters
Hullborne draft, foils down	7.1 meters
Hullborne draft, foils up	1.9 meters
Displacement	241.3 metric tons



BOEING MARINE SYSTEMS

PATROL COMBATANT MISSILE (HYDROFOIL) HIGHLY RESPONSIVE, ALL-WEATHER CAPABILITY

- Speeds in excess of 40 kn and a turn rate greater than 6^{O}/sec with minimum degradation in high seas
- Foilborne operation 95% of time in all seas
- Low-motion environment

ARMAMENT	(1) 76-mm/62 cal. Oto Melara Gun
	(2) Surface-to-surface missile canister launchers
	(2) 4.4-in RBOC launchers
AMMUNITION	(400) 76-mm rounds
	(8) Surface-to-surface missiles
	(24) Chaff cartridges
	Small arms, ammunition and pyrotechnics
COUNTERMEASURES	Rapid blooming off-board chaff
	ESM equipment
FIRE CONTROL	Gun fire-control system
	Surface-to-surface missile ship command launch control set
FOILBORNE PROPULSION	(1) G.E. LM 2500 gas turbine engine (17000 hp)
	(1) Aerojet Liquid Rocket Company waterjet propulsion
HULLBORNE PROPULSION	(2) Motoren-und Turbinen-Union (MTU) MB8V331TC81 diesel engines (1630 hp total)
	(2) Aerojet Liquid Rocket Company waterjet propulsors with nozzle steering and reverser assemblies
ELECTRICAL	(2) AiResearch ME831-800 gas turbine engines, each driving 1 generator rated at 200 kW (250 KVA), 400 Hz, 450V, three phase
FUEL	Diesel oil per MIL-F-16884 (NATO F-76) or JP-5 per MIL-T-5624 (NATO F-44)
HULL	Welded 5456 aluminum
FOILS AND STRUTS	Welded 17-4PH corrosion-resistant steel
ACCOMMODATIONS	24 berths
COMPLEMENT	23 officers and enlisted men
PROVISIONS	5 days

> I think you'll see a turnaround on this. I am going to insist within the Congress that these boats be used and we'll see to it that it gets done. The new Navy needs smaller, faster ships, and it may be forced to accept that.[101]

Schrader and Duff added what they felt were two of the lessons learned offered by the events of 1976 and 1977 related above.

> If the PHM Program is typical, then it appears our NATO commitments and objectives are very easily sacrificed whenever a perception arises that national economic or political realities are altered. It requires surprisingly few complications in the life of a program to make partnership considerations expendable. These are facts which the naive simply have to recognize—at all levels of government.[102]
>
> The importance of a strong, skilled, and dedicated Project Manager is greater than ever. All of the processes of "upward" management depend upon his strength and skill and are probably more vital and energy consuming than even his assigned "downward" management responsibilities.[103]

According to Boeing's first PHM Program Manager, Gene Myers, "although considerable pressure had been building up within the FRG to drop out at this advanced stage, the Germans probably wouldn't have unless the U.S. had offered them a face saving way out. The U.S. opened the door by procrastination."

11. Balancing the Industrial Side of the Equation and the Withering of German Support

Boeing had tried to interest German industry in participating in lead ship development during 1972-3, but with only limited success. With the boom in commercial production and especially exports, Boeing had considerable difficulty enlisting German interest in investment in such a military project, one with only limited prospects for domestic and foreign sales. As broken down on pages 9 and 10 of this sub-chapter, about 17% of the lead ship was European produced with the figure dropping to 7% for the U.S.N. series production PHM's (with the balance of 10% produced in the U.S. under license).

A major example of this problem involved the German firm Zahnradfabrik (ZDF). During source development for design and construction, Boeing attempted in the 1972-3 timeframe to enlist ZDF for development of a major unique component, the foilborne propulsion gear box for the PHM. ZDF however was not interested. With its primary market being gear boxes for trucks and armored vehicles, (where business was excellent) there was little or no interest in PHM work, where there was no guarantee of a sizeable market developing. Moreover, up till the mid-70's German industry generally shunned defense contracting work as it was viewed as unprofitable. In the end, Boeing had to develop and produce the gear box itself for the lead-ship.[104]

The German government for its part, was strongly interested in having the Dutch firm Hollandse Signalapparaten (HSA) build its gun Fire Control System (FCS) for all PHM's. This was to have been the major element of the German work

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DESIGNERS & BUILDERS OF SOPHISTICATED NAVAL CRAFT


TNC 36


FPB 38


TNC 42

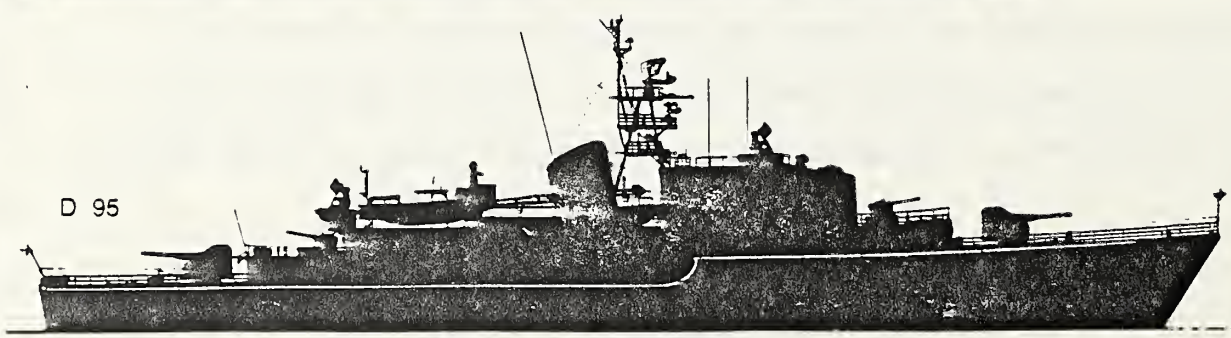

TNC 45


TNC 51


FPB 57


C 71


C 83


D 95

package (though performed primarily in the Netherlands). The German government was especially interested because of the commonality of the PHM's FCS with that of its ten S-143 Schnellboote already under construction (one of the reasons for its consideration for the PHM in the first place). The USN however, nixed this for its series production PHM's as a large segment of the PHM system, and a critical subsystem at that, would have been built off-shore. Moreover, the USN was exploring the possibility of adoption of the GFCS for wider use on other Navy ships, a plan it was soon to carry out.[105]

Boeing continued to build up its joint program based on the NATO Seasparrow experience while lead ship construction was underway. Boeing had already won over the Italian and German governments which had contributed to the launch of the lead ship program in the first place. Now to maintain support for the program all the way through to series production their respective industries had to be locked in. The lead ship contained Italian and German elements, but the German side of the industrial equation was especially unbalanced. The Seasparrow program as well, had only included about 10% European participation during engineering development from three of the five participating European navies, and had to rely primarily on production work to balance the work sharing equation.[106]

Therefore in late 1972, with the leadship construction program about to get underway, Boeing began its campaign to enlist firms for a substantial German stake in series production. Boeing being in a sole source position for lead ship construction, the challenge then became how much of the work could they and the program afford to share to maintain a critical mass of German support.

The firm selected by the German Government to be its German industrial partner for systems engineering work in the FRG was AEG-Telefunken. Luerssen, who had built the S-143 fast patrol boats under sub-contract to AEG, was to serve in a similar capacity for the NATO PHM production in the FRG.[107]

Though German industry had been unwilling in 1972-3 to assume any significant risk in the development of sub-systems, the German shipbuilding team AEG-Telefunken and Luerssen did originally show a strong interest in eventually producing the system under license. Discussions between Boeing and the two German firms began in 1973.[108]

There were basically three options under negotiation with AEG-Telefunken for co-production in the FRG. The first involved AEG acting as prime contractor, with Boeing acting as a supplier of technical assistance and hardware as in a standard license production program (Mode #1 of industrial collaboration). The second involved a joint venture being set up in the FRG to produce the system under license with Boeing participating along the lines of Alinavi and the P-420 hydrofoil (a variation of Mode #1). The third option would have been one where Boeing itself would have been responsible for production of the system in the FRG, subcontracting, out to German industry for a major share of the work (Mode #6 or Mode #7 depending). As one might expect AEG pushed the first option and Boeing the latter. Negotiations drug on over these arrangements from late 1973 into 1975.[109]

One stumbling block was German industry's stance on receiving the background rights for the system to which they felt entitled through their government's

funding of R&D. Boeing was naturally reluctant to enhance any future competitors by giving away without adequate consideration some 12 years of IR&D that had antedated the NATO PHM project, amounting to an investment of some $100 million.

Boeing and AEG could not reach a meeting of minds over the terms of a German production program, i.e., work sharing. With the lack of agreement between Boeing and the German firm, by late 1974 AEG-Telefunken and Luerssen's interest in co-production of the PHM in the FRG, began to sour. This deteriorating situation began to impact the heretofore strong German government support.[110]

As cost and schedule problems increased the original strong working relationships that Boeing had built up with Italian industry and government and the German government could not be extended to German Industry. In all, five proposals were developed for the FRG in an attempt to define an acceptable level of German industrial participation. The attitude of the participants began to change.

Then came the reversal in 1974 when the Two-way Street (Zwei-Bahn Strasse) concept began to replace the US-FRG troop off set agreements, eliminating this inducement for direct purchase and/or unbalanced work-sharing arrangements. Additionally, the German shipbuilding industry had in the interim become severely depressed. National shipbuilding industries are generally one of the most highly protected industries throughout the world. The German shipbuilding industry is geographically concentrated and politically very potent.[111] In addition to having no significant stake in the NATO PHM project, with their

S-143 Schnellboot, the German industry had a competing alternative to fulfill the Bundesmarine's requirement.[112]

Other factors contributing to an undermining of German support during the 1975-77 period, as offered by Joe Madden, Boeing's former German program manager, included:

- The requirement for the German Frigate which, together with another Boeing project, the AWACS, created the largest demand for funds from the Bundesmarine.

- The unavailability of PHM test data which would support a submittal of the program to the Bundestag before the Frigate program was ready itself.

- High cost - which was unsuccessfully tackled by cost reduction alternatives and competition. Blohm & Voss was competed against Luerssen, and eventually MBB and VFW-Fokker were brought in by the German government to compete with AEG-Telefunken.

- An acceptable share of work for German industry was never established in terms of goals. This left industry grasping for solutions. 10 boats in the U.S.; 5 boats in the U.S./5 boats in the FRG; 1 boat in the U.S./9 boats in the FRG. The plan was for the MOD to present a "menu" to the Bundestag and let them (the politicians) decide.

- AEG-Telefunken was marginally interested in the technological advances in weapon system integration offered by the PHM, since the S-143 alternative was not to the same state-of-the-art. Luerssen, however, was interested in further building of fast patrol boats with wooden hulls since that is their main field of excellence and competitiveness. Since both AEG-Telefunken and Luerssen stood to benefit more from the sale of S-143 than PHM, good working relationships between them and Boeing were difficult to maintain.

- The above led to a competition for funding and a loss of socio-economic benefits accruing to the FRG through PHM procurement. The S-143A derivative then came into the picture. Efforts to stress the superiority of the PHM/S-162 over S-143A were interpreted in the FRG as a campaign against its Frigate program, thereby increasing the dilemma for S-162. When the Jetfoil was demonstrated in Kiel to revive German interest, orders went out that no one above the rank of Captian was to participate.[113]

Another relevant factor centered on misunderstandings that arose from the differences in procurement practices between the U.S. and the FRG. The issues of price and the assumption of risk were tied in with the German government's requirement for guaranteeing system performance.

The Germans tended to use ceiling prices for their budget rather than target prices with some additional reserves. The USN finally explained the ceiling prices were too conservative for funding purposes.[114]

The German government and industry had to negotiate the increment in additional cost by assumption of risk by industry. The government then had to elect whether to: 1) increase the contract value with the terms of the contract specifying the additional risk; or 2) to exclude the risk from the contract and hold the additional money in reserve.[115]

These issues made it difficult for the FRG to establish its budget requirement. Moreover, none of the Boeing proposals upon which the German budget requirement for the S-162 were based was ever negotiated between Boeing and the project office since Germany never committed to procure the S-162 on the basis of any one of the proposals.[116]

Naturally, had it been a smooth running, on schedule, and on budget project, German government (and thereby industry) would have been more interested. But as these problems became more severe during 1973 and 1974 support began to erode.

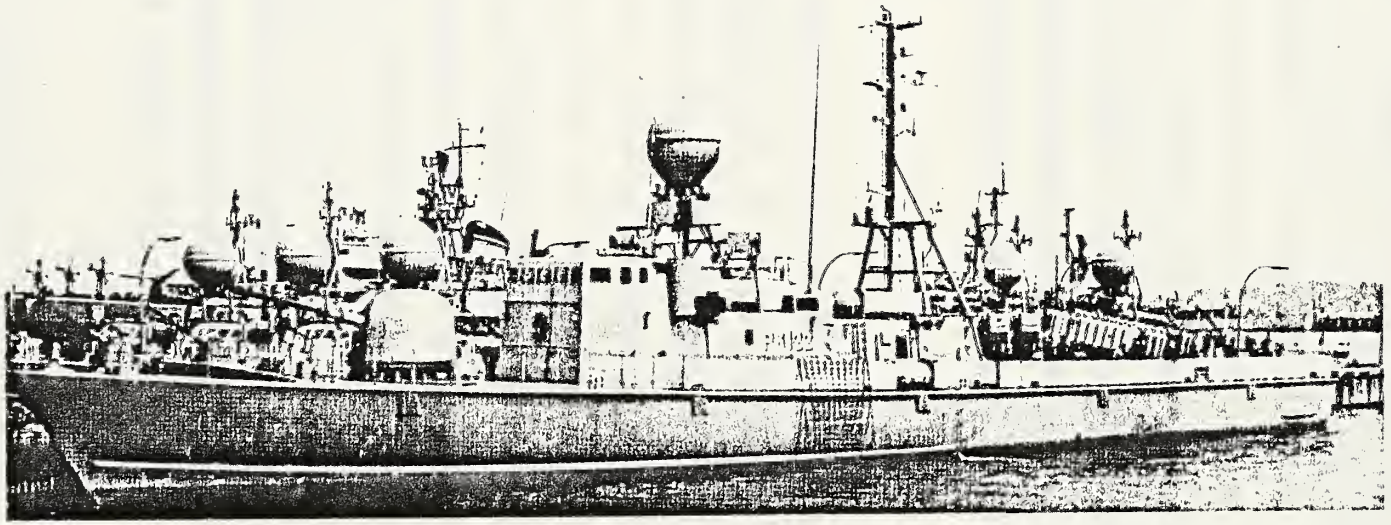
The interdependence of the various nations support for the project has been the crux of the problem. Besides the usual difficulties of maintaining support for a program within the Executive and Legislative branches, and such standard problems as rising costs due to labor, material and unforeseen, but corrected technical problems, the other major problem has been one of working the military-political system of a nation externally (i.e., as a foreigner), with regards to the FRG in particular. As stated by Gene Myers,

> The original support of the German government was not sufficient to carry the program. A substantial work sharing package was required

> to provide a firm foundation for the project. Moreover, it is the technical/quality factor of this work that is most important. It is not simply a question of dollars or marks. Technology participation is critical. What was needed was strong industrial support from within the FRG to sustain it. A government-to-government agreement doesn't make the sale.[117]

Although the NATO PHM requirement involved joint design and development on the governmental side, on the industrial side - where it is even more significant - there wasn't any significant joint development. Hence, from where would come this necessary indigenous industrial support, so vital to sustaining the requirement in the face of constantly changing international environment and competing demands for resources within the other nation's military-political environments?

Within the German government the program also came up against increasing obstacles during the 1975 to 1977 period. As previously mentioned, the German Government's attitude was not immune from that of its industry, which had begun to deteriorate. The NATO AWACS program, moreover, had an impact on funding availability for established programs as well as creating somewhat of a backlash affecting the general attitude toward collaborating with the U.S. on NATO projects. The NATO AWACS project actually came to be seen in some quarters as somewhat of a competitor with the NATO PHM project. There were also a series of changes within the German bureaucracy, (i.e., the FMOD, the BWB, and the Bundesmarine) that led to the replacement of key supporting personnel by others with differing orientations. Then the USN's cut-back of its order in 1975, from the projected 24 PHM's down to six. This had a significant impact on the unit cost of the systems for the FRG.



The 143 A is shown here in service with the 7th FPB Squadron of the German Navy.

As such, the German shipbuilding industry was generally less than satisfied with the benefits offered in the way of technological spin-offs, jobs, and exports, while those elements supporting the PHM project were without significant political clout in the FRG. Add to these the German priorities vis-a-vis employment stability, and the dwindling support within the FMOD and the Bundesmarine due to unit cost, budgeting, and personnel changes, and the NATO PHM project was further undermined.

So when the Carter Administration unknowingly offered the Germans a face saving way out in early 1977, they took it. The purely national alternative of an additional order of another 10 S-143A Schnellboote was chosen over the alternative of 10 NATO PHM's. The official reasoning given by the FMOD for the reversal was the unfavorable logistical impact it would have had on a Bundesmarine already suffering from manpower problems. With limited commonality between the S-143 and PHM (though they did have the same gun and fire control system), it was claimed that supporting the two could only exacerbate the problem.[118]

As for the other European partner, there had been strong Italian government and industry support in promoting the NATO PHM from the start. Italian industry, however, had no real interest in participation in the development effort and the assumption of risk involved. This was in part due to its having been more than adequately compensated by the large U.S. Navy purchase of the OTO Melara gun for the PHM (and other USN ships), with the navigation radar, and a large share in the G.E. LM 2500 engine production. But more generally, this lack of interest was also typical of Italy's placing a lower priority on industrial participation in design and development of military

systems than Europe's three medium powers.[119] In addition to the Italian equipment that would be standard for all NATO PHMs, Italy of course was planning to produce PHM's under license for its own and possible foreign sales.

Therefore, the crucial problem of industrial support (and therefore political clout) played a larger part in the German decision to withdraw, than the Italian decision. Budgetary and cost problems were more important considerations in the case of Italy, though by no means unimportant as far as the FRG was concerned either.

Chuck Slater's thoughts on the subject gained during his years in Boeing's Rome office during the early 70's were shared with the author in 1984.

> Viewed in the largest possible context, it is very improbable that any project as advanced technically and as "radical" as the PHM could be the basis for a solid, successful NATO development program.
>
> Precisely because it was so small (smaller crew, less prestige for the commanding officer) there was an element in the USN blue water ranks not favorably disposed toward hydrofoils. I am certain officers in other navies had similar thoughts about the hydrofoils lack of space, amenities, etc. The Bundesmarine is basically conservative, and I think this finally surfaced. (I suspect the Italian government was heavily influenced by the tremendous success in the 1960's of Carlo Rodriquez of Messina, Sicily, in building surface-piercing hydrofoils for use worldwide.)
>
> With the exceptions of the British and the French, the other allies have very small defense hardware budgets and, consequently, can't afford to, and don't take much technical risk. These people just aren't accustomed to the large cost over-runs typical of the state-of-the-art development programs and can't absorb them economically or politically.
>
> Lower life-cycle costs may play a noticeable role in convincing the USN to consider/buy hydrofoils. I don't think they have any appreciable role in Europe or elsewhere since military pay scales are

so low and the initial cost the craft so high as to really impact total budgets.

Related to the foregoing is the necessity to keep the appetites of the purchasing countries under control. If the German Navy really wanted a credible, highly effective substitute for conventional Lurssen FBP's in the Baltic, they could have bought the P420 or a platform no more than half the size of the PHM. As it was, they went first class, costs got too high and they got out.

12. The International PHM Supplier Team

The principal source of industrial participation for the FRG, and possibly Italy, (and any other NATO nation eventually joining) was to come later through license production of PHM's in their own countries, once the lead-ship/development phase had been completed. However, the lead-ship and later production series ships did include substantial foreign content.

The following is a break-down of the equipment suppliers for the PHM:

The FRG

Supplier	Equipment
- MTU (Bavaria)	diesel engines for hullborn propulsion
- Philips A.G. (Hamburg)	the inner communications system
- Litef-Litton Technische Werke (Baden-Wurtenberg)	the gyro
- Anton Kaeser Klimatechnick (Hamburg)	the air conditioning system

Italy

- SMA	the navigation radar
- Fiat	1/3 of the content of the G.E. LM 2500 foilborn engines
- OTO Melara	76 mm/62 caliber dual purpose gun, which was GFE.

The Netherlands

- Hollandse Signalapparaten (HSA)	the fire control system (FCS). (lead-ship only)

The U.S.

- General Electric	LM 2500 foilborne engine
- AiResearch	accelerator, power units, and compressors
- Aerojet	propulsors, pumps and waterjets
- Western Gear	foilborne gear box (production series only)
- Bendix	frequency converter

The fire control system (FCS) for the lead-ship was built by the Dutch firm Hollandse Signalapparaten (HSA), and in the U.S. by Sperry (under license from HSA) for the five production series PHM's. The lead-ship FCS was German Government furnished, having been originally procured for one of the Bundesmarine's S-143's. The FCS accounted for $7 million per production ship in GFE.[120]

The OTO Melara gun was originally to be procured by the U.S. Navy from Italy only for the lead-ship program. For series production of the five U.S.N. ships, the U.S. licensee of OTO Melara, the Northern Ordnance Division of FMC

Corporation , was to produce the guns. However, due to later difficulties in meeting the schedule, these guns as well had to be procured directly from Italy by the U.S. Navy.

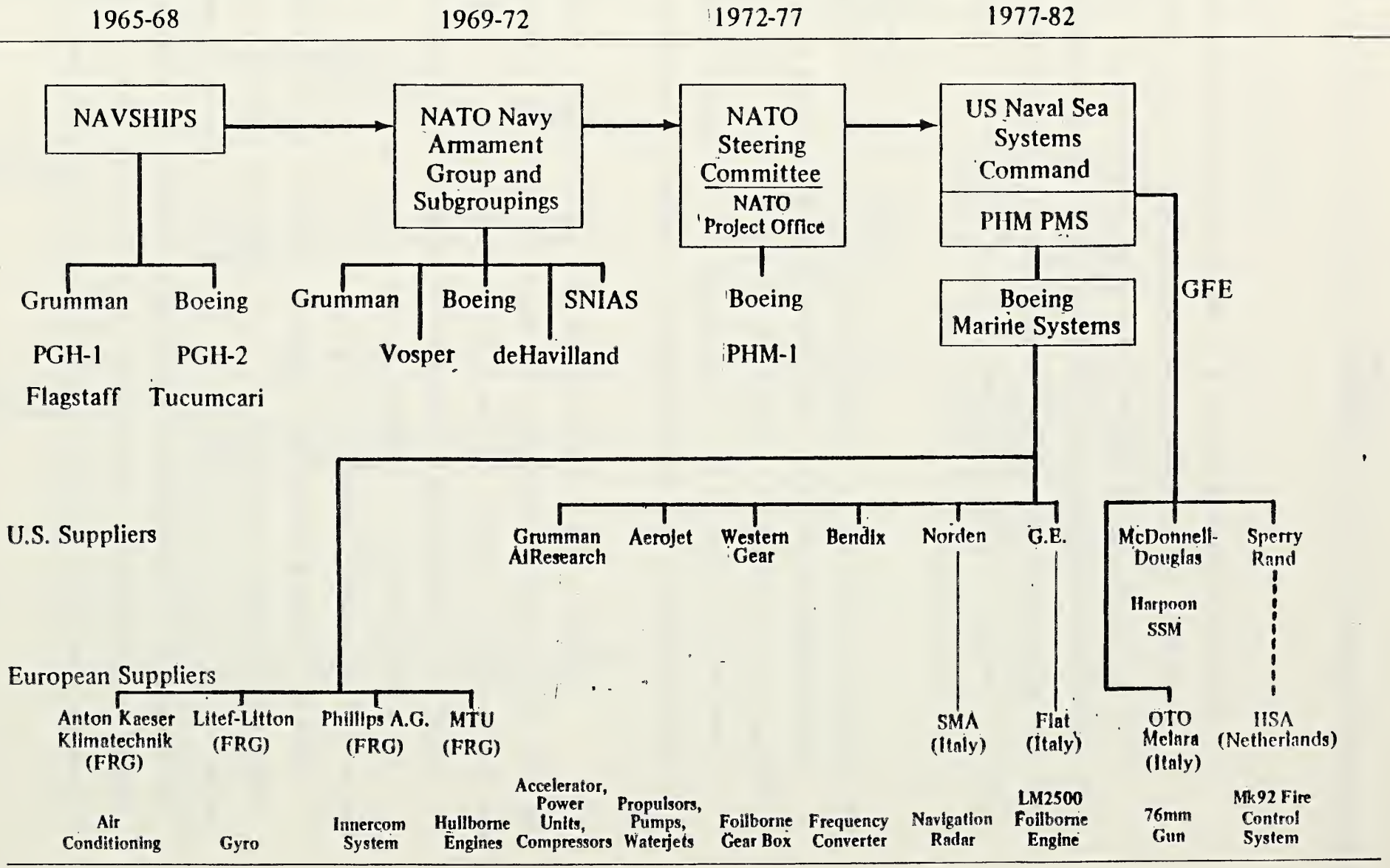
For the five series production PHM's delivered to the USN in 1981 and 1982, Boeing received about $46 million per ship. Boeing placed almost $2 million per ship for both the lead-ship and series production work packages in the FRG and Italy.[121] From among the GFE, totaling about $20 million per series production ship, the Italian-built guns account for another $2-1/2 million per ship.[122]

With total cost per ship at about $66 million, this totals up to some 7%[123] of the production series ship's cost involving direct procurement from Europe, with another 10% (all GFE) being built in the U.S. under a European license. As such, for the lead-ship, the European built portion came to around 17%.[124]

If figured as a percentage of purchased material and equipment for the system, these percentages would be several times higher. For the five production series PHM's Boeing dealt directly with the four German equipment suppliers above, but not the three Italian suppliers. The OTO Melara gun is government furnished, the Fiat participation with the LM2500 engine is as a second tier subcontractor to General Electric, and SMA navigation radar is bought through its U.S. sales agent, Norden.

Being a NATO, as opposed to United States project, the work distribution described above naturally led to the usual 'everything's negotiable' scenario once it came to hammering out contractual arrangements. The problems generated

U.S.N. PHM Hydrofoil Project



by the need to reach a mutual realignment of differing defense procurement practices (along with their underlying conceptual foundations) have already been covered for the negotiations over the manufacturing license agreement between Boeing and AEG-Telefunken for the production of the S-162 derivative of the PHM in the FRG (Section 11). At the lead-ship subcontracting level, the dominant role of the U.S. government and defense industry, and their limited experience with joint design and devlopment projects led to a certain lack of flexibility when it came the flow-down of ASPR and Boeing's own General Provisions to German subcontractors. Though mutually acceptable deviations of common practices were eventually reached, it did take some time and gnashing of teeth. The German firms repeatedly pointed out that they were partners in a NATO project, not subcontractors in a U.S. project.

On the one hand, in negotiating purchase orders, the four German suppliers agreed to provide a cost breakdown, by filling out the U.S. government's DD 633 form. The Boeing Subcontract Manager, German-born Jot Ott, Manager for all of these except MTU, reported that he had never experienced any particular reluctance in the area of submittal of cost data for proposals and during negotiations.

After some initial foot dragging on the part of the U.S. Government, certain socio-economic ASPR provisions were waived, per usual, such as EEO, and Clean Air and Water certification requirements. A virtually unique exemption was granted for the project, however, with regards to U.S. Cost Accounting Standards (CAS). Ordinarily, a waiver is granted to any contract or subcontract over $100,000 awarded to a foreign government, agency or contractor pertaining to

FOREIGN EXCHANGE RISK AND PRICING

OPTIONS FOR OFFSET

Government risk (usually self-insuring if scope of project warrants)	Provides currencies for forecasted contractor/ subcontractor expenditures or E.G. NATO AWACS NATO INFRASTRUCTURE PROGRAMS NATO HELIP F 16	Periodically adjusts billing after the fact (delta between pegged and marked rates) E.G. U.S. ROLAND NATO SEASPARROW	Pays for risk assumed by contractor team if FFP) (or shares with prime if FPI)	
U.S. prime contractor risk/pricing	Flows up risk assumed on foreign currency denominated subcontracts to self insuring governments (ALL PROGRAMS ABOVE)		Prices for risk assumed by prime contractor when subcontracts are denominated in foreign currencies E.G. NATO PHM *	Passes on foreign subs pricing for risk when purchase contracts are in $ can take position that subcontracts be denominated in $ and flow down risk to foreign suppli- levels
Foreign subcontractor risk/pricing	Prices in subcontractor's national currency with no risk (except for the usual escalation/forward pricing estimates) (ALL PROGRAMS ABOVE)			If in $ will price for assumed risk of exchange loss (or cost of buying future $ from bank/gov't financial institution or refuse to bid E.G. RSAF AWACS FRENCH SUBS BCAC CHINOOK OFFSET PRGMS (UK, CANADA, SPAIN)

* For logistics support, however a "cost plus" prime contract passed on risk to customer

the requirements of CAS 403 and subsequent standards. This exception however does not relieve foreign concerns of any obligation to comply with CAS 401 and 402, and to submit a disclosure statement. A special exemption from CAS 401 and 402 was granted for the NATO PHM Project, though.[125] CAS 401 and 402 require consistency of practices in the areas of estimating, accounting, reporting and allocating costs.

In the area of procedural deviations, Boeing for its part had some initial problems agreeing to their German industrial partner's unconditional demands that the purchase orders be denominated in Deutschmarks, which they ultimately were.

No German government audits were ever required for the approximately six and a half million dollars in initial procurement contracts to German industry for the five production series PHM's.

For government provided quality assurance services the US Government's DCAS office in Wiesbaden usually, but not always, delegates its responsibilities to the German government's BWB/GP branch.

As for turn-around time on repairs, Joe Ott reported that the experience with the four German suppliers was averaging between 4 and 13 weeks in mid-1982 depending on the firm. Otherwise the supplier's technicians are brought over to do the repair in the U.S. MTU in particular had an excellent record, having a well developed North American service network, with reps in Tacoma,

Washington, and Houston, Texas. Repairs associated with the SMA radar generally involved longer periods, with particular problems emanating from shipments getting hung up in Italian customs for several weeks, and the difficulty of working through a second party (the U.S. sales agent).

The excellent product support provided by MTU involved an example of another issue. Tech Manuals and other data provided by suppliers or licensors of technologically complex equipment items usually need to be supplemented by some degree of person-to-person explanation to effectuate sufficient transfer of know-how. Though a common phenomenon, this tends to be more accentuated when the supplier or licensor is a foreign firm where there is generally a greater reliance on very specialized technicians and less on documentation. Specifically, the U.S. socio-economic environment is oriented more toward interchangeability of personnel than Europe, where there tends to be less turnover (examples of this were also brought out in Chapter 12 with the F-16 and NATO AWACS projects and Chapter 9 for the U.S. Roland). For the hullborne engines, Boeing found itself relying heavily on the MTU technical representative who was a resident at the nearby Tacoma Boatbuilding shipyard (a designer and builder of conventional fast patrol boats, among others) in order to supplement the Tech manuals it had received as part of the hardware procurement. This was in spite of the fact that Boeing never explicitly purchased technical assistance or even warranty coverage.

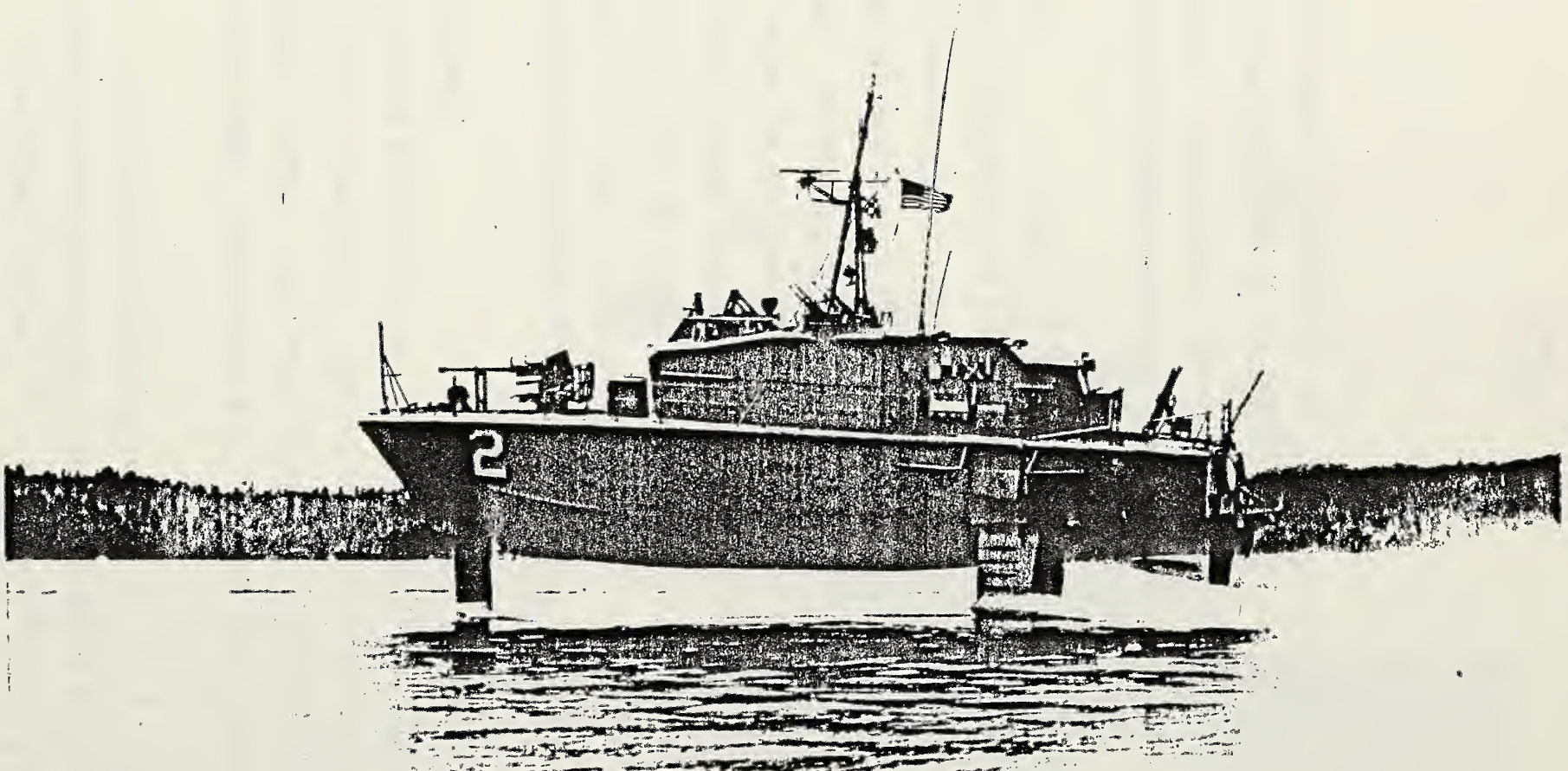
13. The Italian P-421 Class of Hydrofoils and the HMS Speedy

As the NATO program was collapsing, and being continued as a USN project in 1977, Boeing Marine Systems military hydrofoils were beginning to meet with success elsewhere within the Alliance on a bi-lateral commercial basis (i.e. outside of any government to government MOU's).

The development of a Tucumcari derivative in Italy, the P-420 Spaviero, was followed by a contract award for six production series ships, the P-421 through the P-426, in 1977 (as covered in Section 3, sub-section f). These are generally perceived as being substitutes for the originally planned NATO PHM procurement.

Another procurement of a Boeing hydrofoil for an allied Navy involves an earlier dropout of the NATO effort, the U.K. The Royal Navy's HMS Speedy ocean patrol hydrofoil was ordered in June 1978 from Boeing, as the first offshore patrol hydrofoil version of the Boeing Jetfoil. The 115-ton Speedy was launched at Renton, Washington in July, 1979, and was delivered to the Royal Navy in April 1980.[126] This was the first non-commercial derivative of BMS's commercial Jetfoil. Following production trials in Seattle, the Speedy was shipped to the U.K. later in the year for fitting with crew accommodations, rafts, and radio and navigation equipment by Vosper Thornycraft, under a $2.5 million subcontract from Boeing (i.e. about 14% of the total acquisition price of $17.5 million).

Source: Boeing PGH-2 Tucumcari



The Speedy, like the Tucumcari before it, is a 'brown-water navy' ship, destined for operations in coastal waters, whereas the PHM is a 'blue-water navy' ship, i.e., one destined for the high seas.

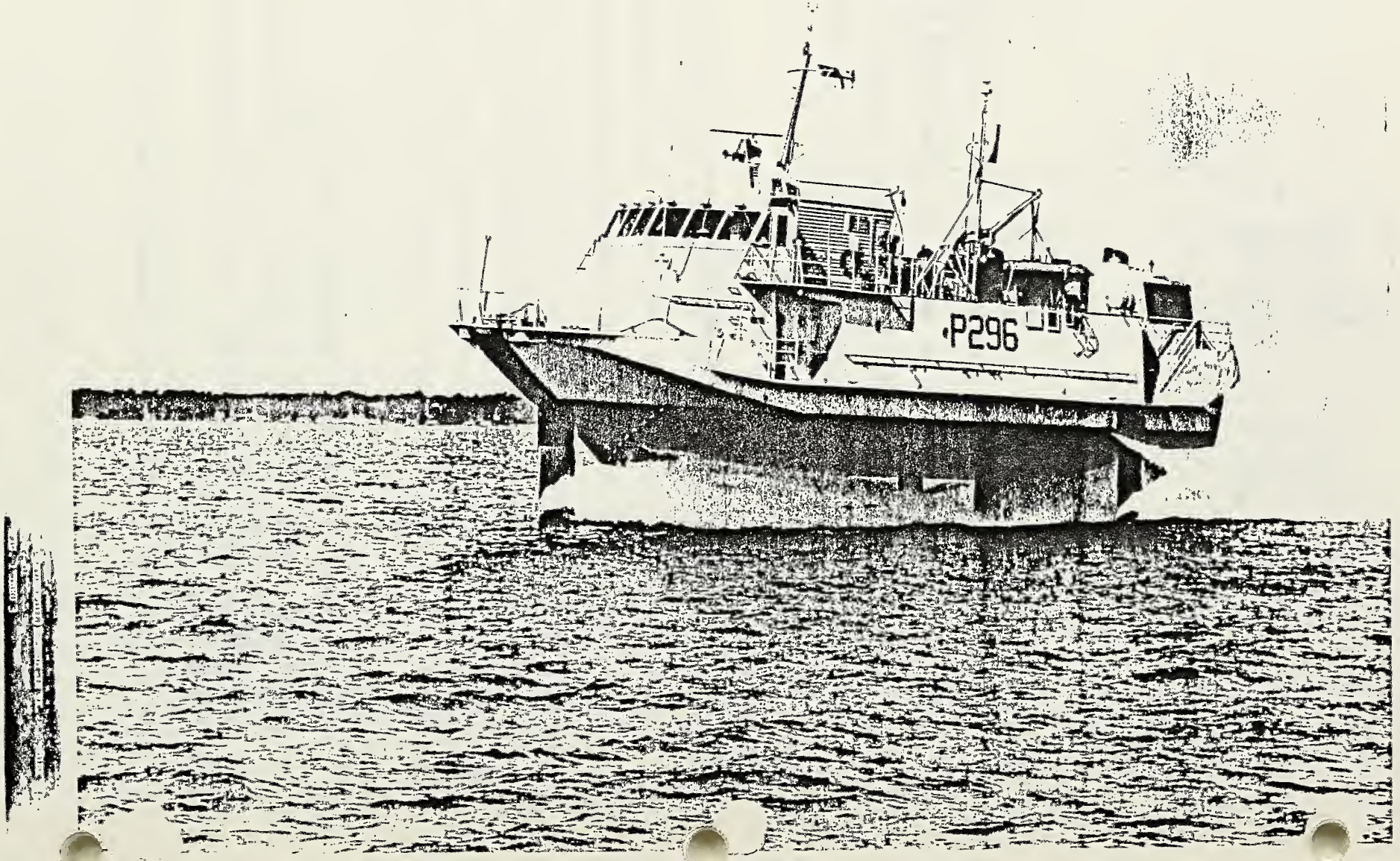
Subsequent to HMS Speedy's commissioning with the Royal Navy in June 1980, the 50-knot hydrofoil underwent trials and crew training at Portsmouth and Portland on Britain's south coast. These included speed and maneuverability measurements, onboard noise trials and other studies characteristic of this type of naval vessel.

Later in the year, the HMS Speedy began a six-month operational evaluation with the British Royal Navy's Fishery Protection Squadron at HM Naval Base, Rosyth, Scotland. During the initial three months of evaluation, Speedy operated in as many fishing areas and with as many different fishing vessels as possible, patrolling throughout the United Kingdom's 200-mile extended fisheries limit. Operations the final three months were centered on roles in which the hydrofoil proved to be most suitable. Fishery Protection Squadron activities include patrols of the United Kingdom's vital offshore gas and oil installations. Evaluation in the anti-submarine and fast patrol boat roles may follow.[127]

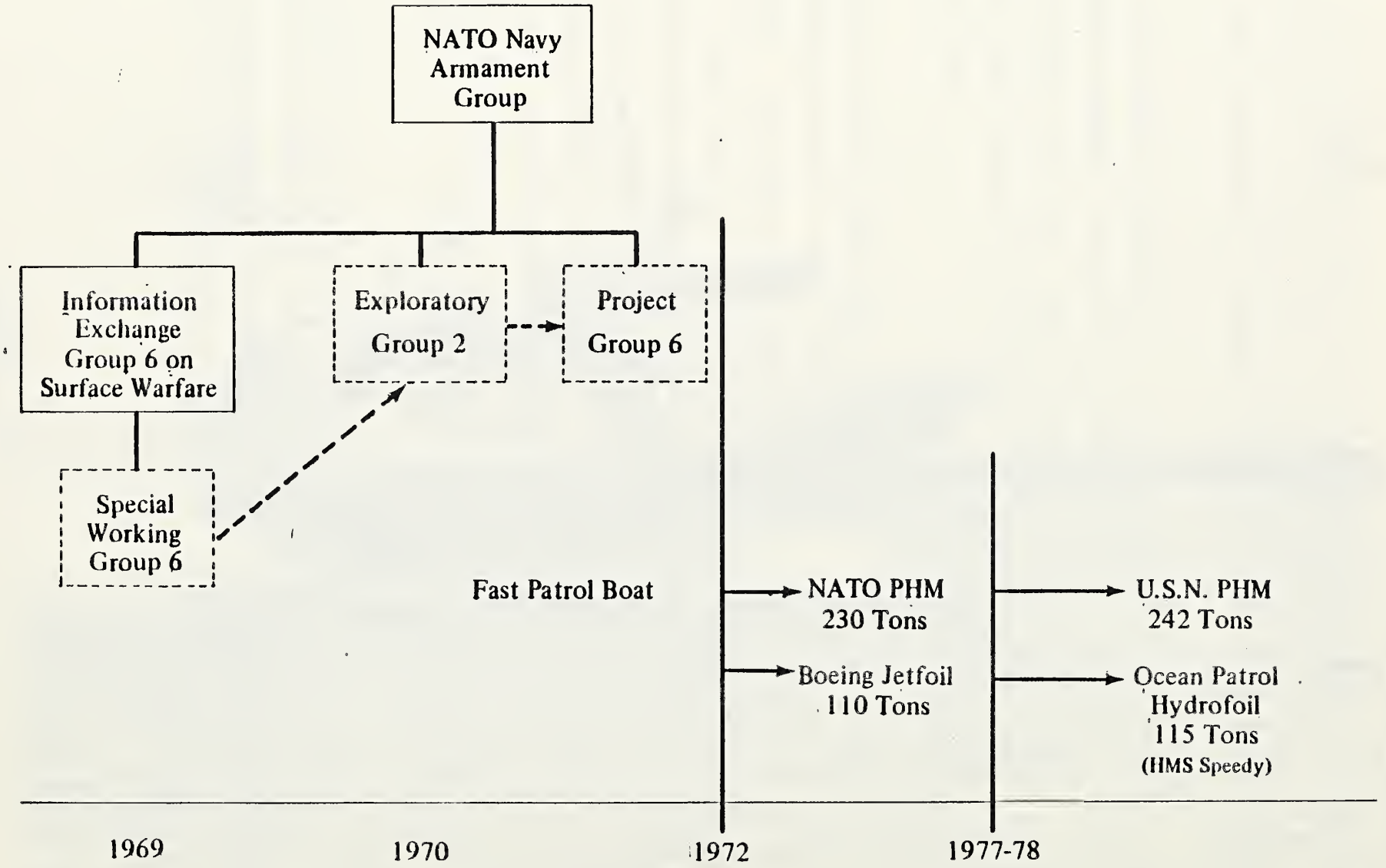
During its transfer to Rosyth, Scotland, Speedy broke the speed and distance record enroute for a Boeing Jetfoil, covering 320 nautical miles from Portsmouth to Flamborough Head, off Yorkshire, at an average speed of 42 knots (48 mph) before refueling in Newcastle. The entire trip was against head

Source: Boeing

Ocean Patrol Hydrofoil (OPH)
HMS Speedy



The British Military Requirement



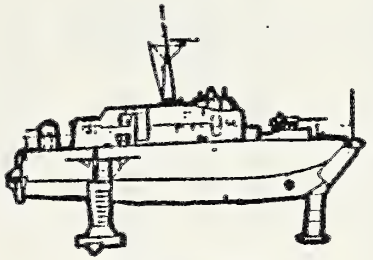
winds between 15 and 35 knots and in moderately heavy seas (sea-states of from two to five).

According to a Royal Navy spokesman: "We are very impressed with Speedy's performance in such bad weather conditions. It is clear it can operate in much worse weather than normal, fast patrol craft."[128]

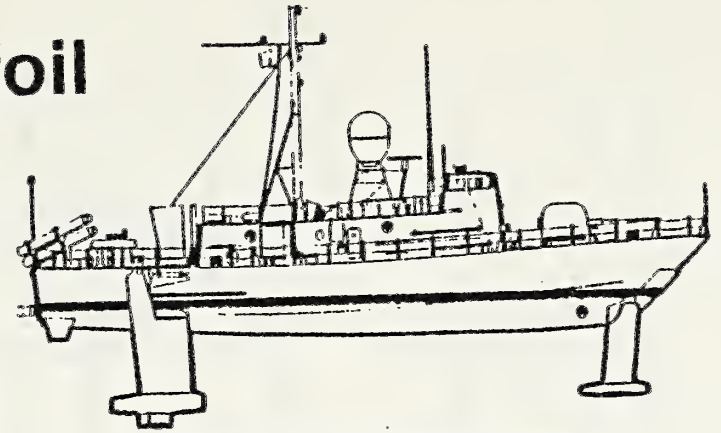
After arriving off the east coast of Scotland, the Jetfoil covered 380 nautical miles in a single day's nine-hour patrol within a 40-mile corridor between Aberdeen and the Firth of Forth, during which its crew identified 43 different fishing vessels. Speedy has also successfully carried out night patrol and boarding exercises. The Fisheries Protection Squadron has found that the Speedy has capabilities comparable to three conventional patrol boats in this role, and thus offers the possibility of considerable operational savings.

The United Kingdom was the first nation to deploy a derivative of the commercial Boeing Jetfoil on naval duties. The aim of HMS Speedy's evaluation program has been to determine the best operating patterns for high-speed hydrofoils to supplement the Royal Navy's existing conventional craft.[129]

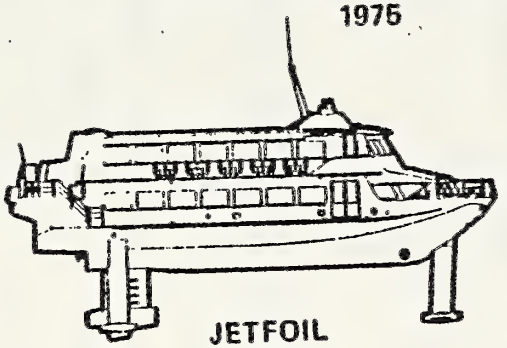
Boeing Hydrofoil Evolution (U.S.)



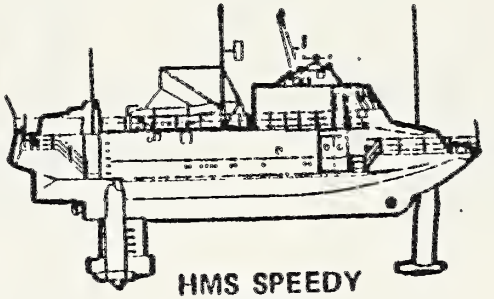
TUCUMCARI
1968



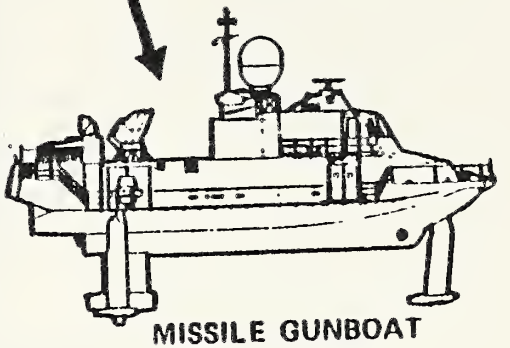
PATROL HYDROFOIL MISSILE
1975



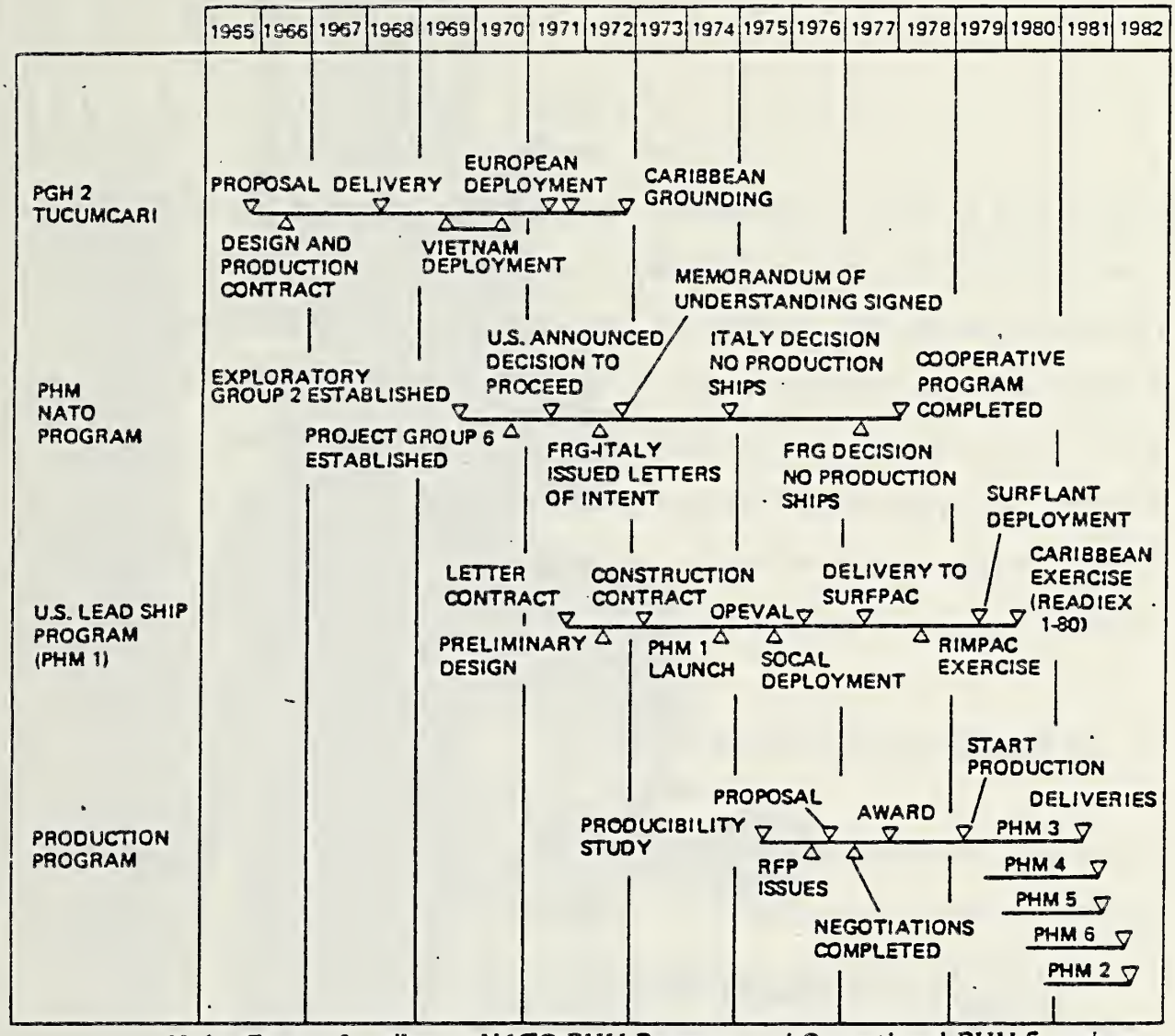
JETFOIL
1974



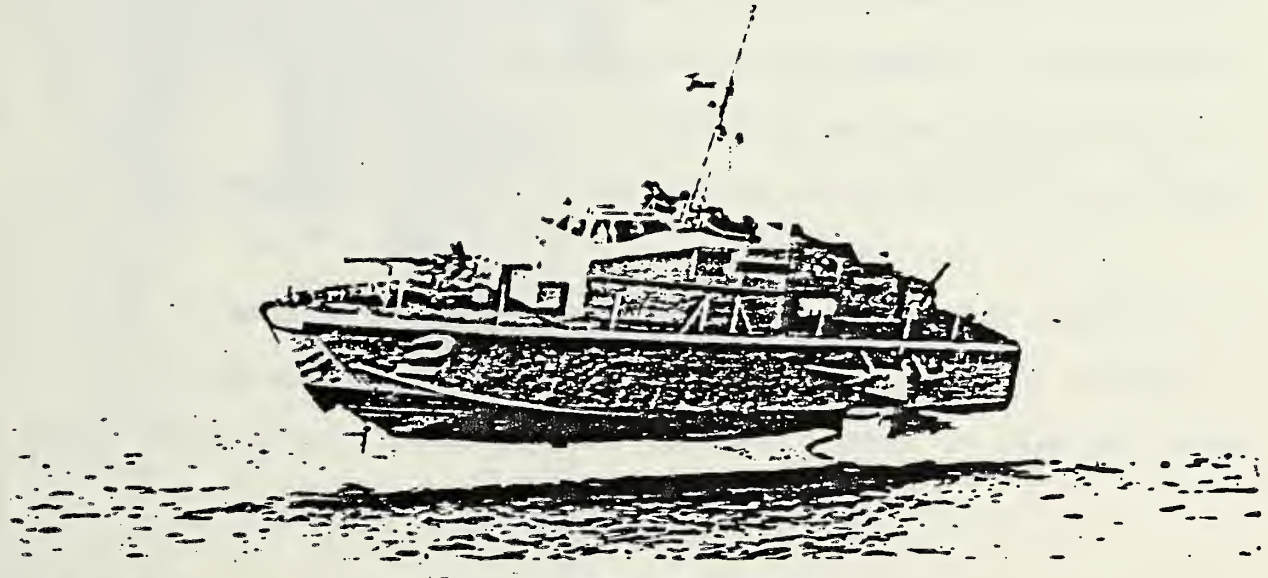
HMS SPEEDY
1978



MISSILE GUNBOAT



Major Events Leading to NATO PHM Program and Operational PHM Squadron



PGH 2 Tucumcari

14. Sequel

After giving birth to a derivative, the Italian Spaviero and the P-421 Nibbio class of hydrofoils, and its follow-on system the PHM, the PGH-2 Tucumcari ran aground off Puerto Rico in November 1972, incurring damage beyond repair. November 1972 also happened to be the month that the U.S., German and Italian navies finally signed the MOU which was to serve as the NATO PHM program's charter. The operational Tucumcari had in the meantime provided a central thread throughout the weaving of a concensus within NATO that eventually generated its follow-on system, the PHM.

a. The U.S. Navy's PHM Program

In the end, following completion of the jointly funded lead-ship program, only the USN entered series production of PHM hydrofoils. In November 1981, the U.S. Navy cited a total 6 hydrofoil program cost figure of $462 million to Congress in its Selected Acquisition Report (SAR). For reasons covered earlier in the sub-chapter, both Italy and the FRG dropped out after contributing $13.5 million and $30 million respectively to the design and development of the system. The German and Italian governments each have their PHM technical data packages (complete up through the date of their respective withdrawals) which, at this point in time, can be utilized as they see fit.

It is doubtful that the PHM program would ever have been launched if it had not been for the initial support of the Italian navy, and then later the German navy with its January 1971 study contract award. The 241.3 PHM design

reflects a compromise between the U.S. Navy's original 170-ton concept and the German Navy's 230-ton concept, but one heavily weighted toward the latter. More generally, the design is one tailored to a military requirement common to a number of our allied navies.

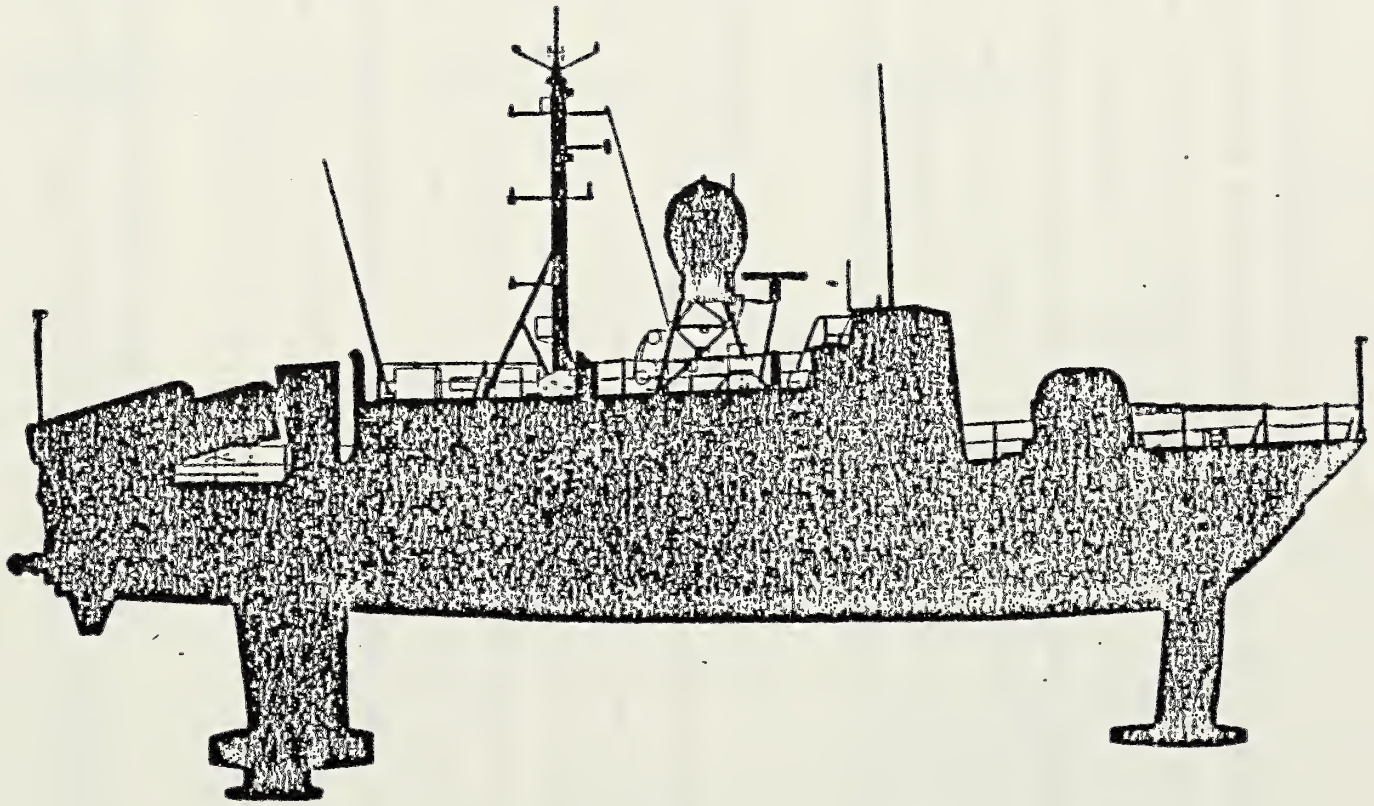
In 1982 and early 1983 Boeing Marine Systems delivered to the U.S. Navy its five production series PHM's (of the PHM-3 class) PHM-3, PHM-4, PHM-5, PHM-6, and PHM-2, the last of which was commissioned at Key West, Florida on March 12, 1983. The six ship PHM squadron is currently stationed at Key West, but an eventual Mediterranean development is planned. In the meantime it is providing a check on the military build-up in Cuba, and participating in the nation's efforts to counter drug smuggling along the Caribbean coastline.

In February 1983, Boeing Marine Systems was awarded a $14 million contract by the U. S. Navy to provide logistics support for the PHM squadron through September of that year. Under the logistics contract, a significant departure from the traditional Navy practice of providing this support itself, Boeing was to manage the procurement, issue, and repair of all spares unique to the PHM's; provide technical support; and serve as the planning yard for configuration control and designed alterations. A follow-on logistics support contract was expected.

b. <u>A Bundesmarine S-162?</u>

Also worthy of mention, is that, as of 1983 the S-162 version of the PHM is

Improved Fleet Effectiveness in the North Sea With S 162's



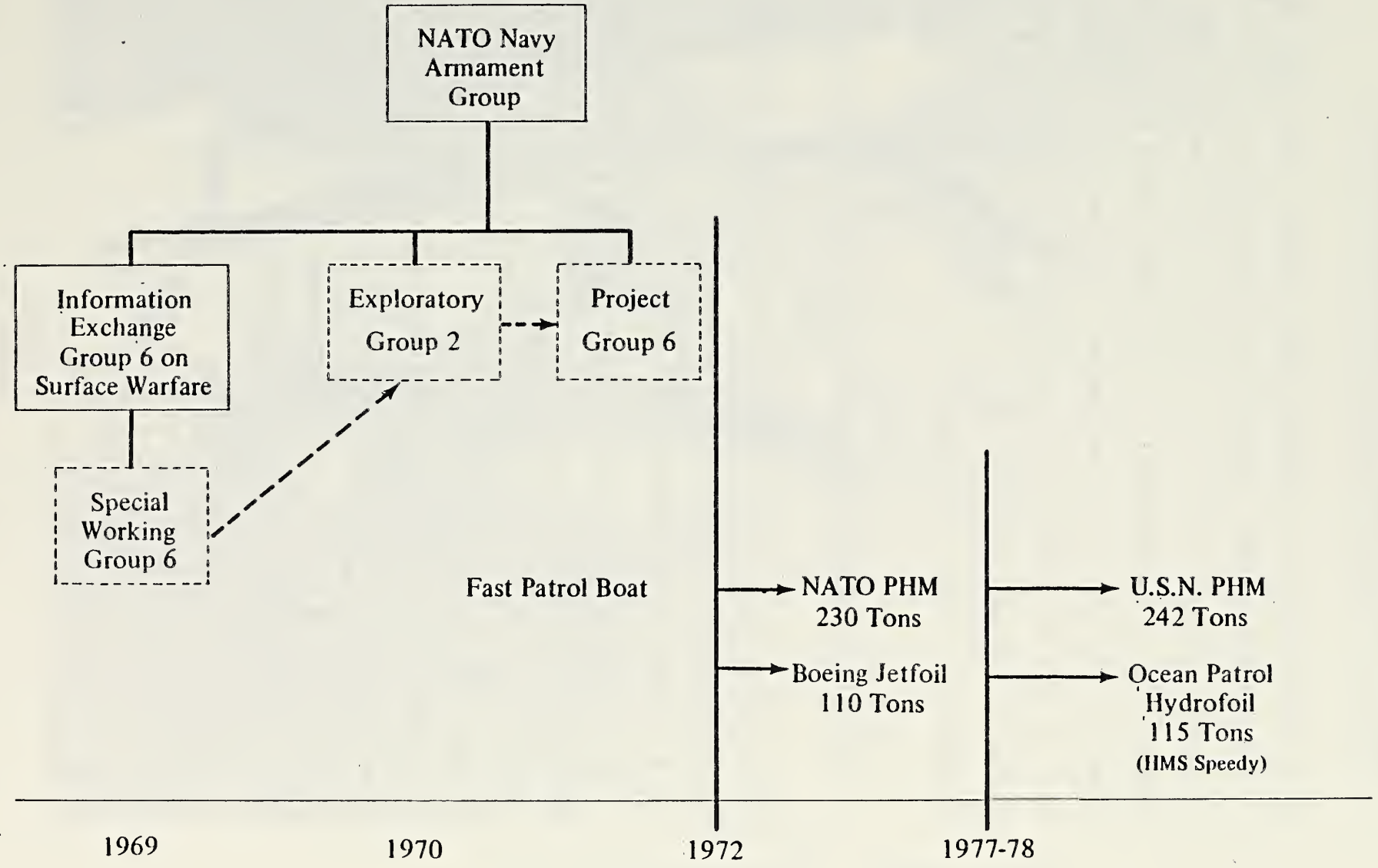
one of several systems under consideration by the Bundesmarine for the replacement of its S-148 around the 1990 time frame.

c. Introduction of the PHM's Italian Gun and Dutch FCS into the U.S. Navy's Inventory and their License Production in the U.S.

In addition to the commonality of the G.E. LM2500 marine gas turbine with a large number of other U.S.N. ships (i.e., FFG-7 class patrol frigates, the DD-963 and DDG-993 class destroyers and the CG-47 class Aegis cruisers) international standardization was also addressed. The NATO PHM program played a critical role in the introduction of two widely utilized European systems into the USN inventory that were adopted simultaneously and on a much wider basis for the USN's FFG-7 class of frigates, and later for the Coast Guard's Bear Class of 270 foot cutters; the OTO Melara 76 mm dual-purpose gun and the Hollandse Signalapparaten (HSA) WM/28 fire control system.

Both of these systems are now being produced under license in the U.S. (Mode #4 of industrial collaboration) , the gun by the Northern Ordnance Division of FMC Corporation and the FCS by Sperry. Yet two more examples of the US Government's willingness to further the two-way street. Sperry's production line was able to get up to speed on schedule.[130] Northern Ordnance took longer however, and not only did the U.S. Navy have to buy the five guns for the production PHM's from the Italian licensor, OTO Melara, but a number of the guns destined for the FFG-7 frigates as well.

The British Military Requirement



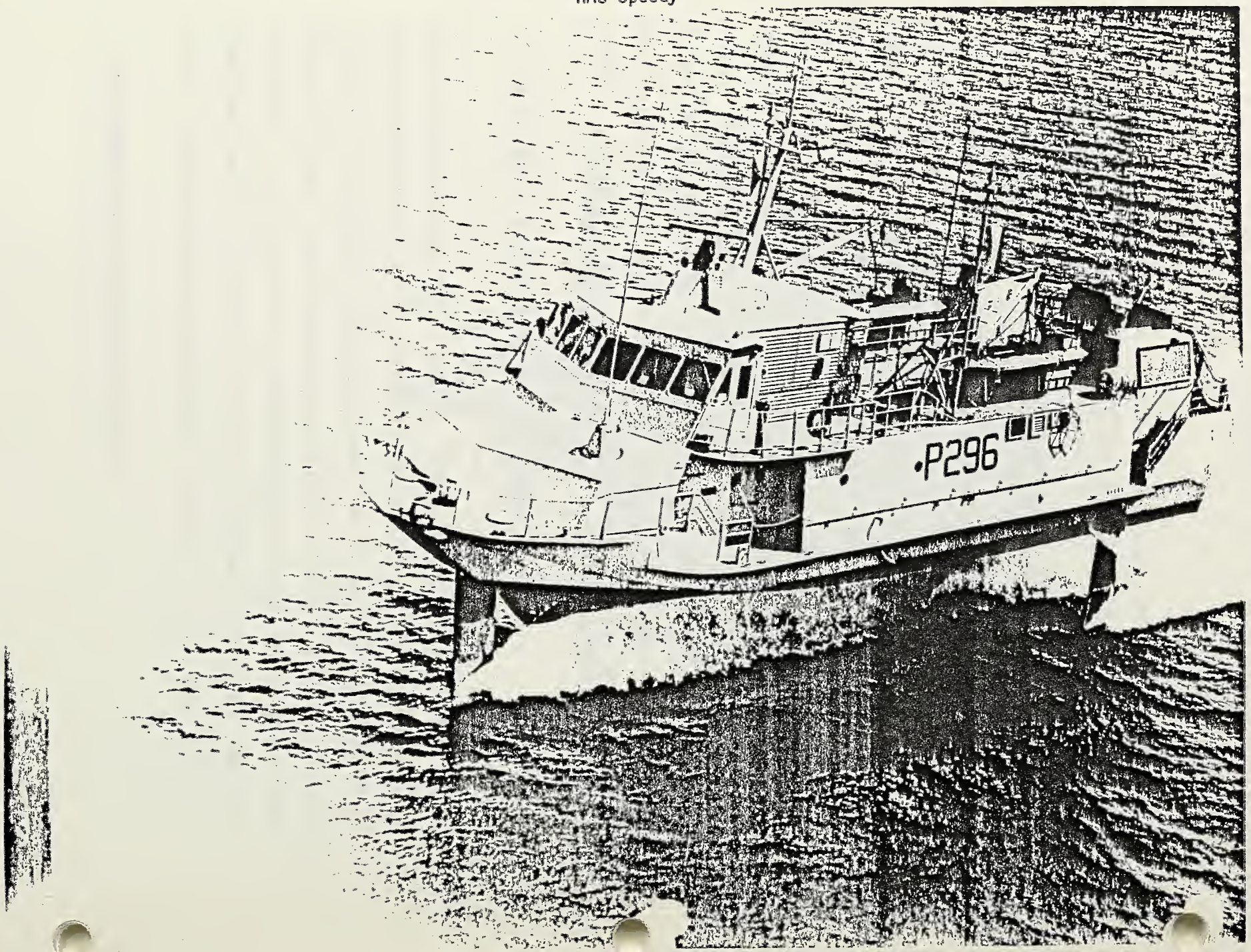
d. The Italian Navy's P-420 Class of Boeing/CNR Hydrofoils

As yet another legacy of the 58½ ton PGH-2 Tucumcari, even though they left the NATO PHM program after several years of participation, the Italian Navy now has an operational squadron of 7 P-420's. The 62 ton derivative of the USN/Boeing PGH-2, has been built in Italy by CNR under a license to Boeing (covered in Section 3 of this subchapter). Moreover, the Spaviero/Nibbio class, as does the alternative to the S-162 selected by the Bundesmarine, the S-143A, is equipped with the OTO Melara 76 mm gun. CNR is optimistic as to the chances for foreign sales materializing in the near future.

e. The British Navy Launches the Boeing Ocean Patrol Hydrofoil (OPH)

Though the British were short of funds and never joined the NATO program, their representative, who served as an observer on NNAG SWG-6 was later to play a critical role in launching yet another line of Boeing military hydrofoils, the Ocean Patrol Hydrofoil with its 1978 order of the 115 ton HMS Speedy, a derivative of Boeings 110 ton commercial Jetfoil-class of hydrofoils (covered in detail in Section 13). At the time of his service on NNAG SWG-6 and PG-6, Jack Daniels was Director of War Ships for British Shipbuilding. As Director General of Ships for the Royal Navy several years later, Daniels oversaw the award to Boeing of a Fisheries Study contract in September 1977 and the placing of the order for the HMS Speedy the following year for its test by the Royal Navy as an off shore surveillance and protection vessel.

Source: Boeing Ocean Patrol Hydrofoil (OPH)
HMS Speedy



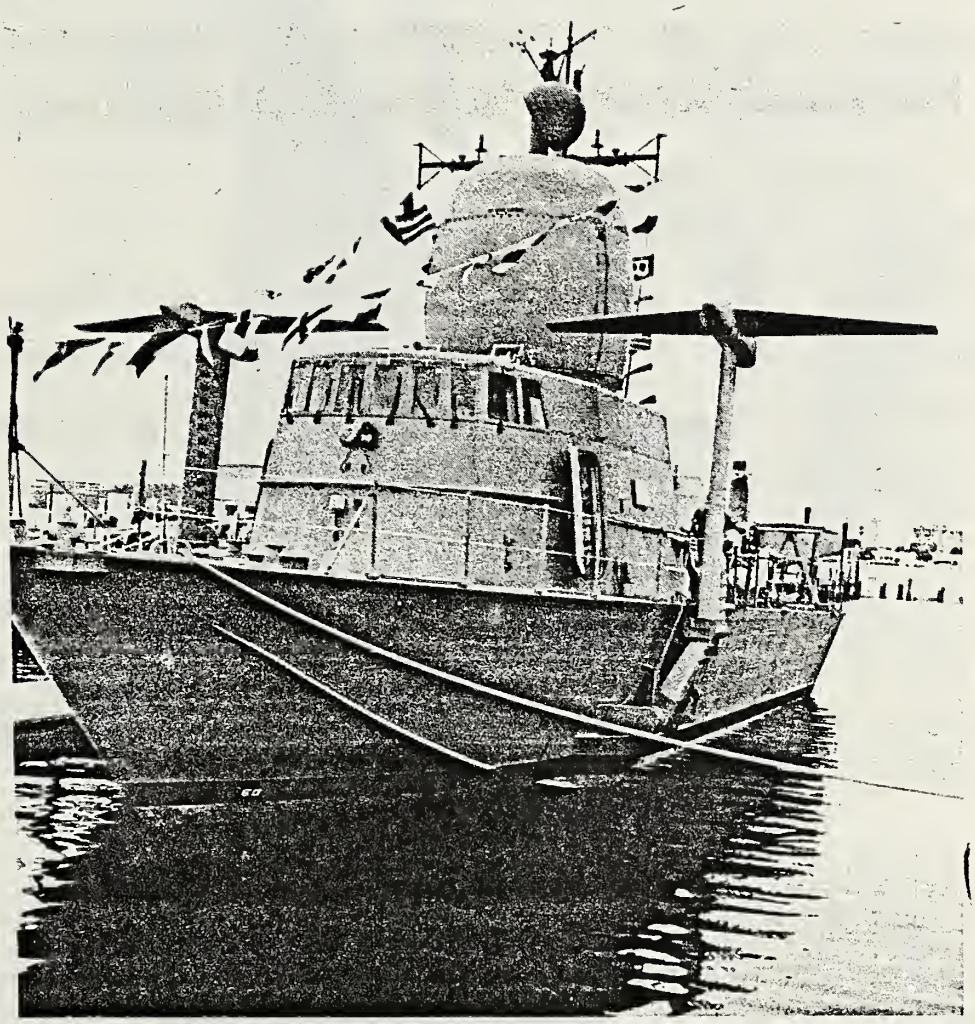
f. The Grumman PGH-1 Flagstaff Resurfaces

In spite of the adoption of various Boeing hydrofoils by three NATO navies subsequent the NATO PHM program's collapse, elsewhere, we again see interest on the part of an allied navy in adopting hydrofoils originally designed and built for the USN. The Grumman PGH-1 Flagstaff resurfaced after losing out to the PGH-2 in the USN/NATO competition, when Israel ordered 2 lead-ships to be built by Grumman for test and evaluation by the Israeli Navy, and considered for possible license production later in the 80's.

g. The Indonesian Navy's Boeing OPH and License Production

The most recent military hydrofoil development involves the Ocean Patrol Hydrofoil (OPH) and a developing nation, Indonesia. The Indonesian Agency for Development and Application of Technology purchased its first OPH from Boeing in 1981, the Bima Samudera I. The ship began both military and commercial operation in Indonesian waters in March 1982. The Bima Samudera I has been used in coastal defense and customs enforcement roles as well as for off-shore oil operations and commercial passenger transportation. The quick change capability of the Jetfoil will enable opertors to easily adapt interior arrangements for a number of varying roles, This derivative of the Jetfoil has double the fuel capacity of commercial Boeing Jetfoils to allow longer endurance missions.

The Indonesian trials covered nearly 10,000 nautical miles during 245 hours under way and proved the Jetfoil stable and reliable. During the demonstra-



Grumman Aerospace has launched a 100-ton hydrofoil patrol boat it is building for Israel. The boat was launched from the Lantana Boat Yard, Fla., and is being tested. The vehicle is designated Design M161 and is a version of Grumman's hydrofoil patrol vehicle, Flagstaff PGH-1. The Israeli boat is 84 ft. long and capable of 50 kt. speeds when foilborne.

tions, the Bima Samudera I established several records, including a continuous foilborne operation of 11 hours, 8 minutes.[131] The Indonesian Navy has identified a long-term requirement for up to 47 Jetfoils. Commercial passenger-carrying Jetfoils would be in addition to that requirement.[132]

In October 1983 it was announced that the Republic of Indonesia had reached agreement with Boeing Marine Systems for a follow-on purchase of four Boeing Jetfoil hydrofoils valued at $150 million and an option for six additional Jetfoils. The agreement includes cooperative manufacture under license of Jetfoils in Indonesia.[133]

The initial contract for the purchase of four Jetfoils for use in coastal patrol, calls for Boeing to assist P. T. Pabrik Kapal (P.T. PAL), the Indonesian national shipbuilding facility, in developing the capability to manufacture the high-technology hydrofoils.[134]

While P.T. PAL will obtain the technical data package, rights and know-how to build the Jetfoils, Boeing will continue to manufacture the critical elements of the struts and foils and the automatic control system, and supply those to Indonesia.[135]

The rate at which the program expands will depend upon the growth in the Indonesian economy, which has been moderate recently due to reduced worldwide oil prices.[136]

If Indonesia opts for the additional six Jetfoils, the value to Boeing would total $330 million.[137]

The first two Jetfoils will be delivered in 1984, followed by one in 1985 and one in 1986. These will be structurally complete hydrofoils with outfitting and interior accommodations to be added by P.T. PAL.[138]

The first two OPH's will be Boeing Jetfoil Model 929-119's while those subsequently built will be Model 929-120's.

The story is by no means told. The 80's will see ever wider adoption of hydrofoils for military use, a phenomenon in which the NATO PHM program has played a leading role.

15. Conclusion

The PHM project started out as a transatlantic joint development project (Mode #5) that could have represented a reasonable compromise between the differing U.S. and European[139] philosophies on joint development. However, it ended up more along the lines of a U.S. led transatlantic production effort along the lines of Mode #7[140] while being procured, at least initially, only by the lead (or sponsoring) nation—the project having become more vulnerable in the meantime to competing indigenous alternatives for fulfilling the requirement and budgetary priorities on the European end.

The NATO PHM and U.S. Roland[141] programs serve as poignant reminders of the U.S. Armed Services willingness to admit substantial allied design input only for the marginal, more controversial military requirements. For the more rock solid military requirements, allies generally enter the picture only after unilateral U.S. design and development, as customers of U.S. systems for which some sort of production sharing arrangement might be worked out, (i.e., Modes #1, #2, #6, or #7 of industrial collaboration). As demonstrated by the history of both the NATO PHM the AVS fighter project and U.S. Roland programs, initially favorable reception of the foreign (e.g., the Franco-German Roland SAM system) or partially foreign (e.g., NATO PHM and AVS) system is contingent upon the ephemereal conjunction of personalities and policy directives. These are easily sacrificed with the resurgence of factions previously held in check within the services, or the change of administrations. On this latter point, the fate of both projects was in part decided by new administrations moving into Washington D.C., looking around for a target upon which to

make their marks, by dispensing with the excess backage of their predecessors. What more likely targets are there than those controversial systems where the requirement is perceived as marginal by much of the service concerned, and therefore one that has to suffer the epitaph of 'political.'

And the DoD wonders why the U.S. has an image problem with regards to our credibility and consistency, and is viewed as an unreliable partner. Of course prospects of technology transfer and access to the U.S. market will both continue to serve as incentives for foreign firms and governments to take the risk of joining up with the U.S. in such projects (Modes #4, #5 and #8 of industrial collaboration). But they will continue to be mindful of the risks, and the large majority of joint design and development projects will continue to exclude the U.S. (Mode #3 of industrial collaboration).

As a comment on the weight placed on the rational allocation of resources in the national decision-making processes in an alliance of sovereign social democratic nations, the project once again shows the limitations on the ability of the member states to hold together on a common endeavor all the way through design, development, and into production, in the face of a host of other competing national priorities. It also suggests the inevitability of considerable unilateral development of weapon systems for the foreseeable future. This latter point seems to be especially true for that large number of systems for which either:

- The cost of unilateral development is not prohibitive, or;
- Those for which there are reasonable prospects of export sales, or;

- Those controversial high technology systems for which a pressing requirement was not clearly perceived by more than one ally, initially at least, as with the PGH-2 Tucumcari and E-3A AWACS projects.

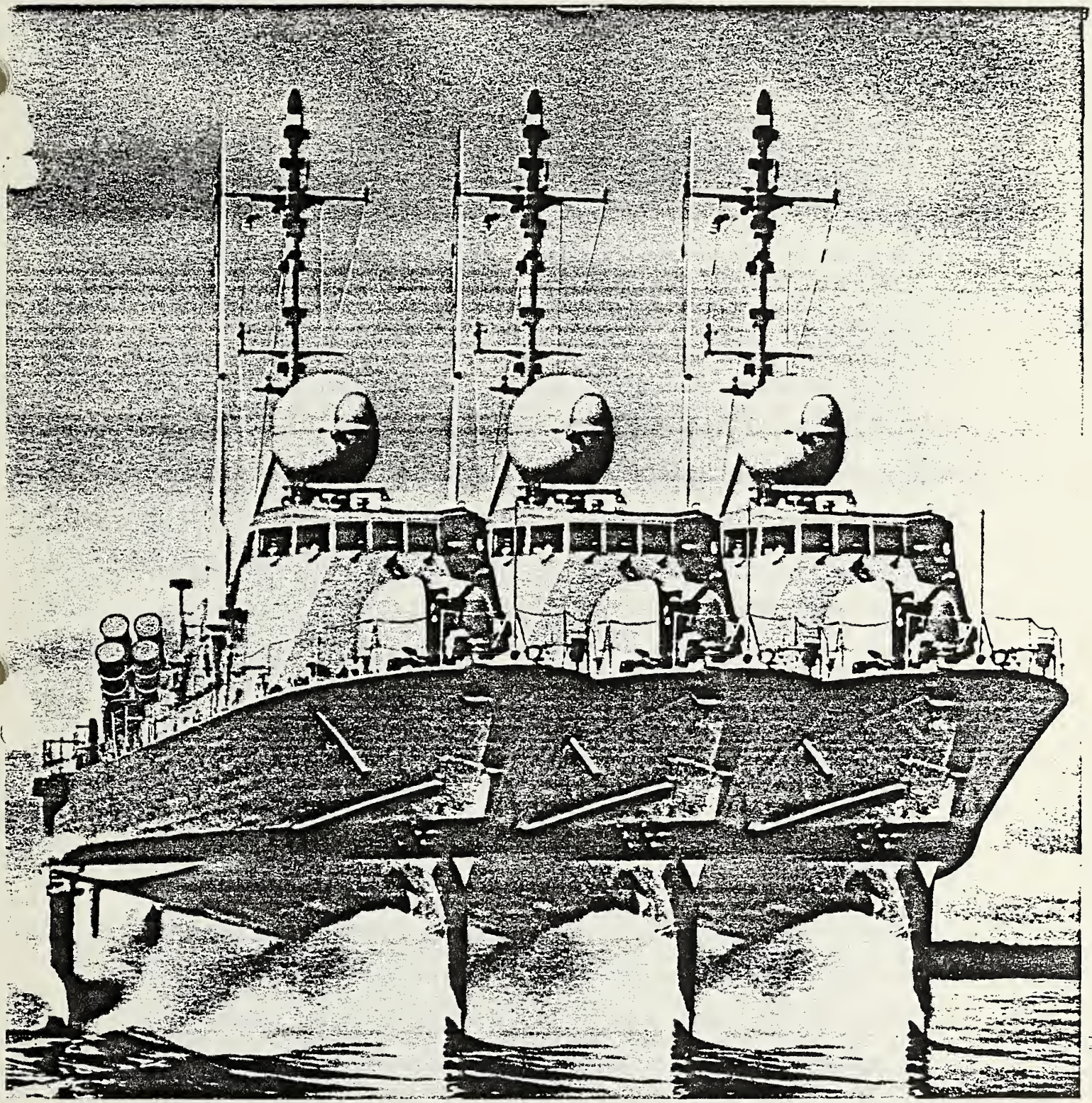
So, not only have three allied navies decided to procure 3 different Boeing Marine Systems hydrofoils, but the remaining nations have been content, at least for now, to fill their requirements through conventional patrol ships. Satisfaction of NATO RSI is conditional upon the fulfillment of such higher antecedents as jobs, the acquisition of technology and exports. Here we have yet another project that has enriched our inventory of examples of the problems faced, and lessons learned, in the joint development and production of weapon systems within the Alliance.

The conclusion to this section on the NATO PHM is provided by several excerpts from a commentary by Admiral Elmo R. Zumwalt, USN (Ret.) on the Schrader and Duff article that appeared in the same issue of Naval Engineers Journal.

> The success of the PHM Program to date and the decision to proceed into production is all the more significant, I believe, in view of the unprecedented number of unusual problems this program has been required to resolve—problems really unlike most of those of any prior conventional ship program. As I recall, in addition to PHM being the first advanced surface ship planned for Fleet introduction, it is also our Navy's first truly cooperative NATO shipbuilding program, first metric ship design, first to incorporate major foreign weapons and electronics systems, and a host of other firsts, as well, including the first total ship operational test program prior to a production decision.[142]

And in response to the criticism that the PHM is just an expensive PT boat, whose utility is limited primarily to that of the tail-dog role, Zumwalt wrote:

> PHM is more than just a small, fast ship. It represents a new naval capability to project significant power at sea in smaller, less



GET THREE FOR THE PRICE OF ONE.

You can buy three Boeing Patrol Hydrofoil Missileships for the same price as one of the next lowest cost combat vessels.

But that's only one reason why PHM is one of today's best defense bargains.

1. PHM burns less fuel and flies with a smaller crew, which lowers her overall operating cost.

2. She's the fastest ship in the fleet. She'll do better than 40 knots. Ride smooth even in rough seas. And turn on a dime.

3. Her speed, manueverability and sophisticated electronics make her practically invulnerable to enemy planes, subs or other ships.

4. She packs one heck of a wallop. Standard weapons include 8 Harpoon missiles, an Oto Melara 76 mm rapid fire gun, a Rapid Bloom Offboard Chaff system, an MK-92 gun fire control system and an ESM system. And with some modifications, you can arm for anti-sub or anti-air or mine laying missions.

5. She's effective in all kinds of weather, in blue water or along the coast.

6. PHM has proven herself. Pegasus, PHM-1, has already joined the fleet and five more are under construction.

All of which means, where numbers count, PHM is a number to count.

BOEING
MARINE SYSTEMS

expensive, faster reacting and versatile units, than we ever had before. Viewed in terms of lifecycle costs, the 21-man PHM really is much cheaper than any competing systems, even considering it from the single mission standpoint. We have not really begun to consider the added value of other mission applications.

My views of high-low mix are already well known; we have to face the reality of need for more ships we can afford.

It may be that we have lost sight of the objective of enabling our NATO allies to share a greater role in their naval defense by actively promoting such naval vessels as PHM. It is my understanding, however, that more recent action by our Departments of Defense and State may be reversing this situation and seeking to promote renewed participation in the PHM Program by our NATO allies.[143]

Schrader and Duff had further developed this last point, that of the challenge the program poses with regards to the implementation of the NATO RSI policy.

There also remains the question of the U.S. intent with respect to PHM and NATO. The original objective of PHM was a relatively low cost naval weapons system which could enhance not only the U.S. Navy's surface warfare capabilities, but those of our NATO allies as well. By enabling NATO Navies to procure ships particularly suited for the coastal and narrow seas environment of Northern Europe and the Mediterranean Sea, it was hoped to also reduce the extent of U.S. Naval Forces committed to these areas. Thus far this objective has failed to be achieved. There is indeed question that it is still perceived as a naval objective by current national leadership.[144]

The U.S. has been criticized in NATO circles for treating NATO cooperative programs as a one way street for Foreign Military Sales (FMS) programs.

To the extent that the United States does desire to increase commonality of NATO defense weapons systems, it is important that we put forward a commitment to procure such systems on a cooperative basis. The NATO PHM Program was the first naval ship program that promised both some degree of truly cooperative production as well as serving a NATO and U.S. naval mission, and third country sales. Yet, when new political and economic considerations were introduced, the basic international considerations of prior years proved to be short lived, and for the case of the Federal Republic of Germany appeared to be easily sacrificed for what were considered to be higher priorities. A challenge remaining today is to reinstate PHM as a viable naval weapons system for NATO. This will require a more committed spirit and promotion of cooperative PHM procurement, mission development, and employment than has characterized the program to date, but is considered nonetheless to be an attainable and worthwhile objective with military and economic benefits too real to be ignored indefinately.[145]

16. PHM—Lessons Learned

The following lessons learned relevant to the inter-allied aspect of the project are summarized below:

1. The decision making process of any government involved in an inter-allied project is extremely sensitive to destabilization by the other participants' intra-governmental disputes over the merits of the project. This is especially true when this merry-go-round is occuring in the lead, or sponsoring, nation, creating havoc in the others. These debates often take place in a vacuum, especially in the U.S., ignoring the partnership aspect of the project and the impact it has on the program budgeting and decision-making processes in the dependent nations.

2. As a result of the above problem, the "upward" management responsibilities of the Project Manager in inter-allied projects are of even greater importance than would otherwise be the case.

3. Jointly funded projects lacking sufficient industrial participation for all nations concerned (i.e., 'sufficient' being a function of such factors as national industrial capabilities and needs, size of expected sales base, and the individual national orders) are extremely vulnerable to order reduction/cancellation. This also displays the bankruptcy of the U.S. 'interdependent' development policy vis-a-vis major systems (summarized on page 2), except possibly within the context of a multi-project grouping such as the Family of Weapons.

4. Closely related to (3) above, is that such projects are easily undermined by competing purely domestic alternatives, even when they offer rather marginal substitutes. This is especially true when such considerations as employment, technology spin-offs and third country sales offer greater benefits for a given nation and thus prevail over the usually lower domestic political priority given to inter-allied projects and Alliance considerations.

5. Industrial property rights appeared once again, as in virtually all other projects, as a major hurdle to be cleared in the structuring of the national work packages. The PHM offered a particularly difficult challenge in this regards.

6. To the above five points concerning the consequences of excessive turbulence at the intra-governmental level in the sponsoring nation and insufficient industrial participation for the partner nations, should be added the industry wide problem of keeping costs under control. Though a pervasive problem, there is no doubt that Boeing and the U.S. Government could have done a better job of wrestling with this slippery beast. Taken together, though there are honest differences of opinion as to how one might prioritize these six points, they do summarize how Boeing and the U.S. Government failed to keep the project sold to the German and Italian navies.

7. Once the above relatively controllable points are treated, then one must take the more deterministic factors into consideration. A basic fact of

life is that inter-allied projects have a greater exposure to disruption by macro- economic and international political developments. This is inevitable. Here we saw the part played by the oil crisis and the subsequent Italian foreign exchange crisis, the world-wide shipbuilding crisis and its effects in the northern part of the FRG, and the evolution of attitudes represented by the discontinuance of the FRG-U.S. Troop Offset Agreements and the appearance of the Two-Way Street concept.

8. Though the above seven points must be summarized as they are a major component of the lessons learned of this particular NATO project, they are offered simply as reminders of well known problems. Where this project history is most revealing is in its earlier phases. Here it provides us with one of the best examples yet of how, with the right product, entrepreneurial initiative can lead to the launching of an inter-allied project in the first place. Whereas the NATO AWACS project offers us a particularly unique example in the selling of an inter-allied project of this scale, it was the USAF, not the contractor that took the initiative. The contractor came in shortly thereafter and performed its support role in this particularly sensitive operation superbly. For the NATO PHM project, on the other hand, a small contractor team working not only through the U.S. Navy, but a number of European navies, played a more significant role in initiating and guiding the project. How this was woven together is probably the most interesting aspect of this project from a historical viewpoint.

9. More generally this project offers us another glimpse at the workings of NATO's Main Armament Groups. It is particularly useful in this regards as it serves to 'flesh-out' the otherwise sterile organization chart and procedures commonly available for orienting the uninitiated. The dynamics of concensus formation in this highly politicized decision-making environment with regards to agenda, source selection and intergovernmental coordination are of particular interest.

10. One specific instance of these dynamics that is the second most revealing group of lessons learned (or better yet warning signs of dilemnas to be encountered) of this project are centerd on the MOU negotiations. These took place within the framework of the NATO Naval Armament Group's (NNAG) Project Group (PG) 6 during the second half of 1971 and later under the aegis of the three nation NATO Project Steering Committee through most of 1972. This involved juggling the following: the strings to be attached to utilization of the Technical Data Package under a royalty free license once the jointly funded lead-ship design, development construction and operational evalution program had been completed; interdepartmental coordination within the U.S. Government; and separating the wheat from the chaff (i.e., sifting out the less than serious nations while still allowing adequate time for each prospective participant to line up his ducks), while attempting simultaneously to get substantive MOU negotiations off the ground and carrying out a design study aimed at adequately meeting the differing military requirements of the yet fluid set of particpants.

11. Systems involving significant foreign design input are generally only candidates for filling the more controversial (and what is perceived as marginal) requirements of the U.S. Armed Forces. Vested interests in the Pentagon and industry work very hard to keep foreign design (and manufacturing) input out of the programs which are solid, high priority, and have good business ($) potential. This controversial/marginal requirement problem and the higher visibility of inter-allied project tends to make them easy targets when shifting political fortunes within the services, or a new Administration, bring to the fore a new set of actors unencumbered by the long-term inter-allied partnership commitments of their predecessors and calling for a sacrifice on the alter of "I'm in control here."

12. As a result of the above phenomenon (11), the cost control problems endemic to the industry as a whole, become even harder for the U.S. to justify for inter-allied projects. Cost problems that are pardonable on the more rock solid military requirements, tend to become mortal sins for those requirements involving inter-allied projects, i.e. when the requirement is inevitably less firm; partnership considerations being more highly expendable in the U.S.

13. It is especially difficult to stuff the differing, and often mutually conflicting military requirements of two or more nations into one system. The NATO PHM, after the reduction of participating nations down to five, and then to three, was able to attain a militarily acceptable balance between a standard ship and national variations for the equipment weapon

suit (though this did contribute to cost increases). It was the budgetary, economic, and industrial problems that arose in the mid-1970's that eventually broke up the joint project.

14. And finally, this project history provides yet another example of the intractability of the problem of Alliance-wide standardization and the orchestration of the various military requirements, replacement schedules, budgeting processes, and so forth. Three of the allied Navies active in NATO's Project Group 6 have each acquired different Boeing Marine Systems hydrofoils, while the others have continued to procure conventional patrol ships.

[1]Jane's Surface Skimmers, 1980, p. 297 (Moreover the PHM can negotiate 8 ft. waves at speeds in excess of 40 knots).

[2]The Fire Control System consists of the radar, displays and weapon system controls.

[3]Joseph N. Schrader and Cdr. Karl M. Duff, USN, "The PHM:Surface Warfare Ship Technology Takes a Step Forward," Naval Engineers Journal.

[5]An approach that we see is more acceptable on lower level R & D projects.

[4]At least when the joint German-American AVS and Anglo-French Variable Geometry (AFVG) fighter projects were cancelled in the 1967-68 time frame, the UK and the FRG had their two halves left to start the MRCA Tornado project.

[6]Jane's, op. cit., p. 294.

[7]NATO Patrol Hydrofoil Guided Missile (PHM), a brochure published by the Dept. of the Navy, Naval Ship Systems Command, Washington, D.C. in mid 1972, p.5. (Hereafter referred to as "NATO PHM, NAVSHIPS. . .")

[8]Ibid.

[9]Ibid.

[10]One year is the maximum time allowed under NATO document for participating as an observer, C-M(66)33, by which time each nation had to put up the money to join, or drop out all together.

[11]Ibid

[12]BMS also produces a commercial jetfoil.

[13]In addition to Boeing, the list of competing firms included Lockheed, Hughes, Martin plus three others.

[14]Stefan Geisenheyher, "Hydrofoils are coming of age," Asian Defence Journal, 7/81.

[15]Ibid.

[16]In fact, Boeing designed the PGH-2 to permit a turn radius of less than 100 meters at speeds up to 45 knots. Furthermore, although no specific requirement was imposed by the U.S. Navy for maneuvering in heavy seas, Boeing chose to design the Tucumcari so that maneuvering would not be impared by rough water operation.

[17] The Tucumcari not only satisfied the trials requirement for an uninterrupted 400 mile transit in open seas but exceeded the required 40 knot average speed by 6.1 knots. During this transit in the Pacific Ocean off the coast of the United States, significant wave heights of 3.5 to 4.0 meters were negotiated, while foilborne.

[18]Following an inconclusive completion of Operational Evaluation (OPEVAL), the two ships were deployed to Viet Nam in the fall of 1969 and the winter of 1970 for six months of coastal patrol duty between Danang and the DMZ.

[19]In turn, during overhaul in 1973, the PCH-1 High Point's foil and propulsion systems were revised, as previously mentioned, to incorporate several of the advances proven by the Tucumcari: a steerable forward strut; and anhedral configuration (foils canted downward from center to tip) of the aft foil.

20 The superiority of the Tucumcari in the critical area of reliability and maintainability became glaringly evident during the Fall 1969 - Winter 1970 Vietnam deployment of the two ships.

[21]The Otomat surface-to-surface naval missile was jointly developed by OTO Melara of Italy and Engins Matra of France, and was one of several missiles under consideration for the Italian variant of the NATO PHM.

[22]Francesco Cao, "Proving the Swordfish," International Defense Review, Vol. 7, No. 6, 1974, p. 755.

[23]Ibid., p. 756.

[24]Ibid.

[25]Ibid., p. 757.

[26]Ibid.

[27]Ibid.

[28]Ibid.

[29]Interviews with Boeing's former Tucumcari Project Manager (1965-68) and the first PHM Project Manager, Gene Myers (October 1971 - August 1973), between October 1977 and May 1982.

[30]Ibid.

[31]Ibid.

[32]Utilized by the PG-84 240-ton fast patrol boats built by Tacoma Boat.

[33]The German Military Procurement Agency

[34]Though the Germans were responsible for much of the pioneering work in surface piercing hydrofoils, having developed the technology during World War II, they couldn't close the gap when efforts picked up again in the mid-1960's.

[35]Myers, op. cit.

[36]Ibid.

[37]Marinetechnik Planungsgesellschaft mbH, a brochure dated August 1976 published by MTG, p.5.

[38]Ibid. p.6.

[39]Ibid.

[40]There were still reservations, however, voiced by many in both industry and the defense establishment as to the merits of having such an organization. They expressed misgivings that industry had encouraged creation of companies for accomplishing tasks which traditionally had been (at least in part) a government prerogative. This raises problems in the competitive area, since these companies include personnel belonging to corporations which are defense contractors. Even with the best of intentions it was widely understood that some conflicts of interest and a degree of curtailment of competition were unavoidable.

The German frigate project, for one, reportedly demonstrated in the early 70's that the existence of an organization like MTG severely limits the customer's freedom of choice with respect to awarding the contract for ship system definition.

[41]Ibid., p.8.

[42]Actually though the Dutch HSA WM-28/52 was the baseine offered in the Model 928-70 baseline design , the French Thomson Vega FCS was also offered as a second option (the one originally mated to the Aerospatiale Exocet MM-38 anti-ship missile).

[43]Throughout this period and over the next several years there was constant internal pressure within Boeing which kept introducing Boeing's German affiliate, MBB, into the picture as Boeing's German partner over MTG, and later AEG Telefunken. At this point in time Boeing owned 8.9% of MBB stock.

[44]Myers, op. cit.

[45]Though the developmental proposal was put on the shelf, the KKB-162 study's evaluation and ancilliary efforts continued through the summer and into the fall.

[46] Correspondance of R. G. Merritt between July 1971 and January 1972 (hereinafter referred to as "Merritt correspondance").

[47] Ibid.

[48]Myers, op. cit.

[49]Ibid.

[50]Grumman was considering submittal of a protest over the source selection as they felt the decision was questionable, but never did. Subsequently, Grumman's participation continued with the award of further hydrofoil R&D work from the Navy.

[51] Myers op. cit.

[52]Ibid.

[53]Ibid.

[54]Ibid.

[55]Ibid.

[56]According to a 1974 GAO report on cooperative research and development programs, the UK and Canada failed to participate in the PHM program for several reasons, one of which was budgetary problems (the others weren't mentioned). One would take note, however, of the common, if no inevitable, phenomenon of NATO allies having "difficulty" finding funds for an official NATO project representing a system for which there own domestic competing design (and the military requirement it was tailored to) had lost out.

[57]Charles H. Slater, letter to author, February 1984.

[58]Myers, op. cit.

[59]Ibid.

[60]The day of D.B. Cooper's Hijacking of an aircraft shortly after take off from the Seattle-Tacoma (SEATAC) International Airport, while the PHM project people were across the street celebrating the award in a hotel.

[61]Merritt correspondance, op.cit.

[62]Myers, op. cit.

[63]Both the NATO Project Steering Committee and the NATO Patrol Hydrofoil Project Office would remain 'provisional' until the MOU was actually signed and NATO Project Group 6 was dissolved.

[64]NATO PHM, NAVSHIPS, op. cit., p.8.

[65]Ibid., pp.8-10.

[66]Officials responsible for the NATO hydrofoil fast patrol boat program stated that the participants had problems deciding on whether to use the metric system, the Anglo-Saxon system of measurement, or both. This took several months to resolve. Finally, since some of the already developed components were made

according to the metric system and some according to the Anglo-Saxon system it was decided that a mixture of the two would have to be used. A metric hybrid design was consequently resorted to as it was impractical to produce a design based on a uniform measurement system. (Comptroller General, op. cit., p. 23.)

[67]Adm. Ruzzia was Italy's Technical Procurement Chief for Ships, equivalent to the USN's Naval Sea Systems Command.

[68]Myers, op. cit.

[69]Mr. Tympe, a civil servant, as is the norm in the FRG for such assignments was the BWB's Deputy naval architect.

[70]Myers, op. cit.

[71] Meyers, op.cit.

[72] Merritt correspondance, op.cit.

[73] Ibid.

[74] Ibid.

[75]NATO PHM, NAVSHIPS, op.cit. p.15

[76]Ibid.

[77]Ibid., p.17.

[78]The S-148 procurement involved one of the more unique bi-lateral off-set arrangements (Mode #6 of industrial collaboration). It was the purchasing nation, the FRG that had to place orders for 10 of its 20 Luerssen S-148's in France (Cherbourg) as part of a deal allowing the Bundesmarine to receive the much sought after MM38 Exocet anti-ship missile (the first of its kind) several years sooner than it otherwise would have.

[79]The HSA WM/28 FCS was a one-gun version of the WM/27, which handled two guns.

[80]Myers, op. cit.

[81]NATO PHM, NAVSHIPS, op.cit., p.27.

[82] Ibid., p.26.

[83]The MK 92 FCS on the FFG-7's have capabilities above and beyond those on the PHM as they are not only controlling a gun but also a SAM system. Consequently they have a cross field amplifier that provides a longer range, and a continuous wave guidance system for the missiles.

[84]NATO PHM, op.cit., p.26.

[85]Ibid., p.28.

[86]The FRG for its part had spent 1 milion DM for the development of the KKB-162 spec.

[87]The U.S. too had a routing/higher level coordination problem but of a different sort. In 1977 the Office of the General Counsel, Office of The Secretary of Defense (OSD), assumed a central policy coordination role for the proliferating inter-allied MOU's. Prior to 1977 there had been none. Every U.S. service's acquisition components had been carrying on their own negotiations. Sometimes less than ideal MOU's had resulted. Unlike our European allies with whom they had been dealing, the DOD had no small cadre of experienced negotiators in such matters. U.S. negotiators were often new at the business of negotiating MOUs. A number of very lop-sided agreements had resulted. A 1977 DOD directive finally began to tackle the problem by requiring all such agreements be sent up to the OSD's Office of the General Counsel for approval.

[88]In actuality, the chairmanship was never rotated, the U.S. rep retaining the position through dissolution in 1977.

[89]The U.S. payment includes amounts which were made available for obligation and expenditure prior to the entry into effect of this Memorandum.

[90]Section III of the MOU distinguishes between the Standard Design and the Variation Design.

> NATO PHM Ship Standard Design means the technical information (describing the design features, configurations, equipments, components, materials, installation characteristics), and other requirements which are desired by the Participating Governments to be uniformly applicable to all NATO PHM Ships to be acquired under this cooperative project.
>
> NATO PHM Ship Variation Design means the technical information and other requirements which are specified by an individual Participating Government for application, initially, to its NATO PHM Lead Ship.
>
> NATO PHM Ship Production Data Package is the integrated total of the technical information comprising the two above designs.

[91]Schrader and Ruff, op. cit.

[92]The choice of the word 'Supplement' was not without significance. The reason the follow-on MOU was set up as a 'supplement' was that the U.S. wanted to make it clear that this was not a design only lead ship project. On this point, some par-ties thought that, as a supplement to an MOU, the full administrative sign-off process could be avoided. This was not the case. Though, it tied in with the first one, it was a whole new agreement.

[93]Most of the new engineering talent being brought back in came from the Saturn and other NASA programs based out of Huntsville, Alabama and Michoud, Louisiana. NASA business in general was fast disappearing at this point in time. Later inputs of technical and managerial personnel came from Minuteman and then the Boeing Commercial Airplane Company.

[94]Schrader and Duff, op. cit.

[95]Ibid.

[96]The dichotomy between the lead ship and the production ships is not all that clear cut. Block I includes PHM-1 and part of PHM-2 (work having been suspended in August 1974), while Block II includes PHM-3, 4, 5, 6 and the remainder of PHM-2, PHM-2 also involved some surplus equipment from Block I since the design of the production ships (Block II) is different from that of the Pegasus and the original PHM-2.

[97]The delay however, had caused a $13 million increase in the program's estimated cost. And since an internal Navy reprogramming to provide this funding shortfall was subsequently disapproved by the Secretary of Defense, the PHM-6 was to be delivered without a weapons suit. The funds for the PHM-6 weapon suit were finally obtained in FY81 with installation planned for 12-15 months following delivery.

[98]Schrader and Duff, op. cit.

[99]Ibid.

[100]Ibid.

[101]Timothy Egan and Eric Nalder, "Navy's hydrofoils fast becoming idled," Seattle Post-Intelligencer, March 25, 1982., p. A-9.

[102]Ibid.

[103]Ibid.

[104]Myers, op. cit.

[105]Ibid.

[106]Ibid.

[107]Myers, op. cit.

[108]During this period, 1973 and 1974, AEG helped Boeing in its drawn out efforts to obtain U.S. Government waiver of the flow-down of its Cost Accounting Standards (CAS) some elements of its Armed Services Procurement Regulations (ASPR) to German industry.

[109]Interview with a former Boeing PHM Materiel Manager, Earl Hagen, November 1981.

[110]Ibid.

[111]This concentration was in the North, while what German industrial participation there was, was scattered across the country.

[112]Myers, op. cit.

[113]Joe Madden, Boeing's PHM German Project Manager from 1975 to 1977, memo to the author July 1982.

[114]Ibid.

[115]Ibid.

[116]Ibid.

[117]Myers, op. cit.

[118]Myers, op. cit.

[119]Though Italy had hovered on the sidelines of the first three inter-allied joint designed development projects (all of which were Franco-German), the Atlantic, the Transall and the joint tank project that resulted in the AMX-30 and Leopard I, it was only able to come in later for the production phase of two of these, and belatedly at that. This involved an offset a la Mode #6 for the Atlantic maritime patrol aircraft and license production (Mode #1) for the Leopard I. The largest inter-allied development project ever, and one involving the Italians, the MRCA, was only just barely able to keep them on board; at the price of subsidy through favorable financing and work sharing terms during design and development. As we saw in the previous sub-chapter concerning the NATO Seasparrow project, Italy assumed a minor role in design and development, but dropped out of the follow-on development project, the SLMS.

[120]Joe Ott, Materiel Manager, Boeing PHM program, interviews between March and June 1982.

[121]Two-thirds of this being built in the FRG and one-third in Italy.

[122]Ibid.

[123]Of this 7% that was European built (4% GFE and 3% CFE), 85% came from Italy and 15% from the FRG.

[124]Ott, op-cit.

[125]John S. W. Fargher, Jr., "Financial Management of Defense Codevelopment and Coproduction Programs," National Contract Management Journal, Volume 16, Summer, 1982, Issue 1, p.8.

Later UK contractors, for performance substantially in the UK, also received an exemption provided that the UK contractor has filed a completed disclosure statement with the Ministry of Defense.

Boeing had sold a total of 23 jetfoil as of late 1981.

[126]"Speedy sets record en route to UK evaluation in Scotland", Boeing News p. 5, 12-18-80.

[127]Ibid.

[128]Ibid.

[129]Ibid.

[130]After an initial program that involved production in the U.S. in the mid-60's at Sperry of only two evaluation protytpes of an earlier model HSA FCS, the WM/22 (with no follow-on production orders), the U.S.N. and U.S. Coast Guard have adopted the more advanced WM/28, now in series production (see Chapter 9).

[131]"Indonesia Order Four Jetfoils worth $150 million," Boeing News, p. 4, October 6, 1983.

[132]Ibid.

[133]Ibid., p. 1.

[134]Ibid.

[135]Ibid.

[136]Ibid.

[137]Ibid.

[138]Ibid.

[139]Meaning primarily the 3 medium powers.

[140]But one involving some joint funding of development work carried out unilaterally by U.S. industry, as with the AWACS and F-16 projects.

[141]Mode #4 of industrial collaboration.

[142]Elmo R. Zumwalt, Admiral USN (Ret.), Naval Engineers Journal, June, 1978, p. 16.

[143]Ibid.

[144]Ibid.

[145]Ibid., pp. 16-17.

F. NATO SEASPARROW

1. Background: Evolution From the USN's IPDSMS to NATO's NSSMS

A. The Participants

The NATO Seasparrow Surface Missile System (NSSMS) is a ship-based point air defense system with a range of about 20 kilometers[1] that was jointly developed by an industrial team of U.S., Norwegian, Danish, and Italian firms. The NSSMS is jointly produced by the original grouping of firms from these four nations, plus several more from Denmark, the Netherlands, and Belgium. A total of 86 ships in eight NATO navies plus the navies of two other allies, Spain and Japan, are equipped with this surface to air missile (SAM) system. For the U.S.N. this involves the 12 attack carriers (CVN's) and all of the DD 963 Spruance class destroyers.

The system has been procured by the Navies of the six producing NATO nations, plus two other NATO allies, the FRG and Greece, as well as two non-NATO nations, Spain and Japan. The NSSMS has the distinction of being the only major transatlantic codeveloped weapon system to have achieved success.

Much as with the F-16 coproduction effort (which involved no joint industrial development however) some seven years later, the U.S. was able to interest the four smaller northern NATO members (Belgium, Denmark, the Netherlands, and Norway) in participating in a transatlantic effort, over European alternatives. Italy, generally in the same category as the four northern members, joined the U.S.-led NSSMS effort in 1968.

Dannebrog Electronic A/S

constructs the NSSMS microwave receiver at *Arhus, Denmark.*





J.P. Anderson
Vice Pres.
Systems Division



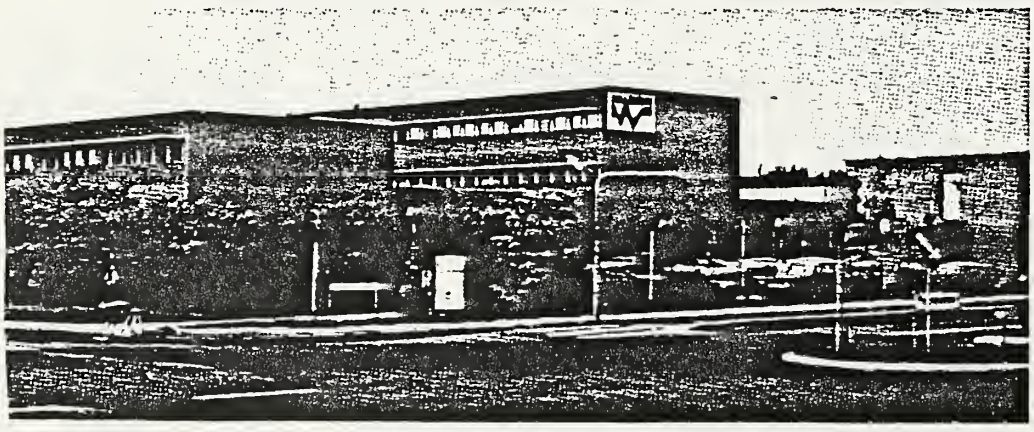
Henning Jensen
Program Mgr.
Systems Division



Lis Clausen
Assembler, complex critical circuit boards

NEA – Lindberg

of *Ballerup, Denmark,* manufactures transmitter static frequency converters.





Jorn Finnich
President



Bent Rasmussen
Purchasing Mgr.



Ole Fehrn
Mgr. Quality Control



Erik Fenger
Project Engineer



J. Green-Petersen
Vice President

As is the norm, the three European medium powers followed their separate courses.[2] The FRG eventually gave up its unilateral effort, the Koumar, and decided to buy the NSSMS on an off-the-shelf basis in 1977, too late for any offsetting production participation. The U.K. is procuring its Sea Wolf point defense system, developed and produced by Marconi and British Aerospace, while France is working on a ship-based version of the Crotale surface-to-air missile, the Naval Crotale, developed jointly by the French firms Thomson-CSF and Matra.[3]

B. The USN's Improved Point Defense Surface Missile System

The NATO Seasparrow surface missile system (NSSMS) utilizes one of the Sparrow family of missiles that were designed and developed by Raytheon for the U.S. Navy and U.S. Air Force. The NATO Seasparrow missile, nomenclatured the RIM-7H, is built around the technologies that created the AIM-7E Sparrow 3 air-to-air missile. The RIM-7H missile itself is a modification of the USN's AIM-7E model.

The NSSMS emanated from a larger U.S.N. program known as the Point Defense Surface Missile Systems (PDSMS). The PDSMS were all developed around the AIM-7E and the program covered three individual projects during the 1960's: the Basic PDSMS; the Improved PDSMS (soon to be the NATO Sea Sparrow); and the Advanced PDSMS. The Basic and Advanced PDSMS were both independent U.S.N. efforts throughout. However, only the former program, the Basic PDSMS, ever made it into production.

The Basic PDSMS uses a modified 8-tube ASROC missile launcher with a manual fire control system and the AIM-7E missile. Its development began in 1964 with Raytheon as prime contractor. Raytheon failed to win the production contract,

however, one which was awarded to Frequency Engineering Laboratories. Raytheon only produced the Sparrow 3 missile for the system.

The Improved PDSMS, or NATO Seasparrow, incorporated a new lightweight 8-cell launcher, a fire control system (FCS) using digital computers, a Target Acquisition System (TAS) with dual-mode sensor, and a power-driven director/illuminator radar. Its RIM-7H missile is a modified AIM-7E2, having folding fins to enable it to fit into the smaller launch cells. The RIM-7H can function in any installation which is designed for the AIM-7E, thus facilitating depot testing and maintenance.[4]

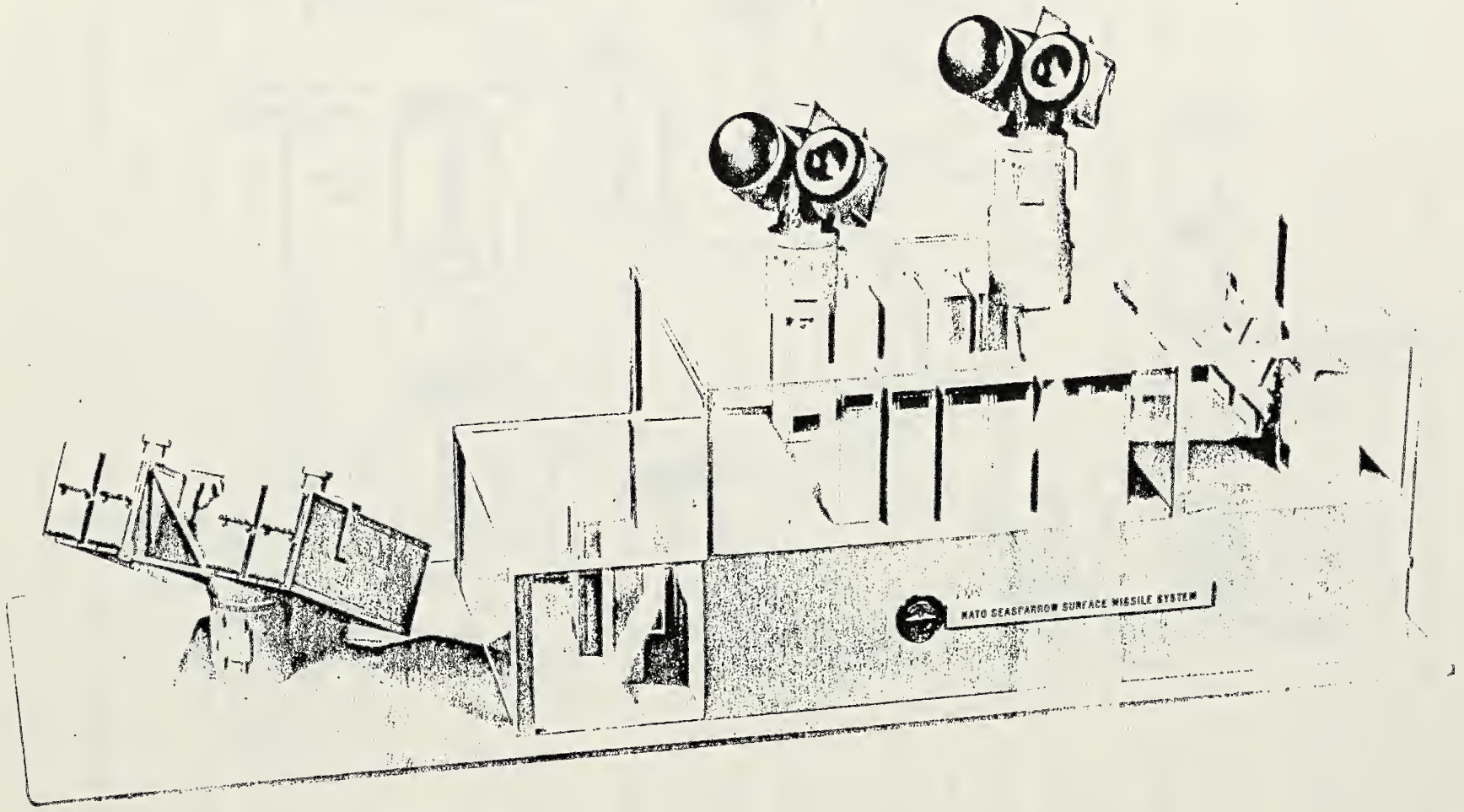
In 1966, the Applied Physics Laboratories (APL) of Johns Hopkins University, supporting the U.S.N.'s Point Defense Systems Manager, was given the task of writing the Performance and Capability Requirements for the fire control and launcher system of the Improved PDSMS, shortly to become the NSSMS. Once the documentation produced was put into a design and performance specification format with the assistance of the Vitro Corporation, a contract was let for the six-month Contract Definition (CD) phase. The contract was awarded to Raytheon by the U.S. Naval Ordnance Systems Command in June, 1968.[5]

C. The NATO Program Takes Shape

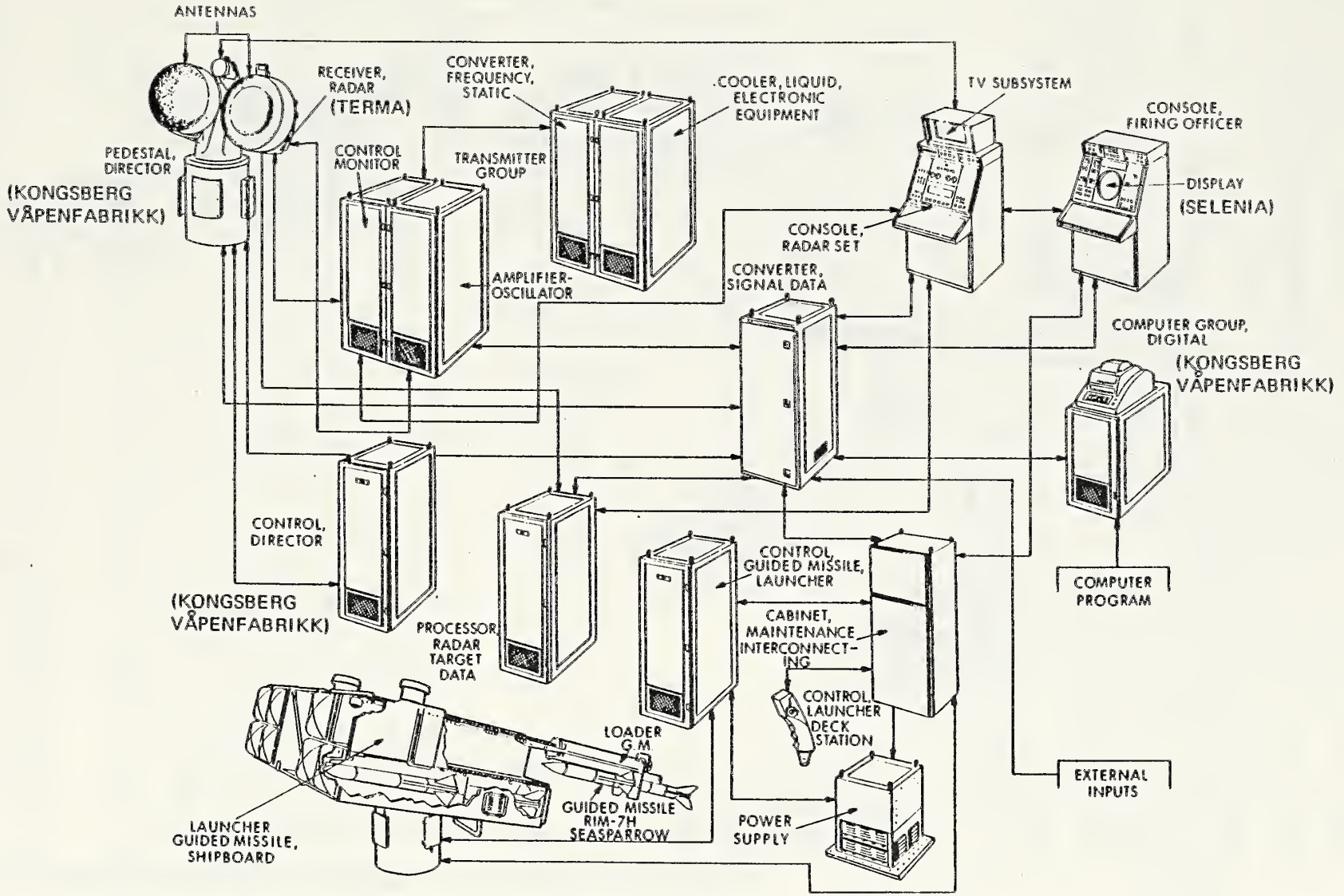
Meanwhile, in Brussels, a parallel line of developments was occurring. In late 1966 NATO abolished its prior organization for promoting collaborative weapon systems programs - the NATO Armaments Committee and its subgroupings - and its procedures for promoting cooperation in research, development, and production of military equipment, based on the NATO Basic Military Requirements (NBMR's) - and contained in NATO Document, C-M(59)82. NATO replaced them in early 1967 with the Council of National Armament Directors

NATO SEASPARROW SURFACE MISSILE SYSTEM

- GUIDED MISSILE FIRE CONTROL SYSTEM EX 91 MOD 0 (SINGLE DIRECTOR)
  MOD 1 (DUAL DIRECTOR)
- GUIDED MISSILE LAUNCHING SYSTEM EX 29 MOD 0



NSSMS SINGLE DIRECTOR SYSTEM



(CNAD) as the new capstone committee, and a new set of procedures as set forth in Nato Unclassified Document, C-M(66)33. NATO had experienced considerable difficulty with the prior procedures, dating from 1959. Though the NBMR procedures had been intended to be a flexible and practical means of encouraging armaments cooperation, they in fact became overly rigid and led directly to the successful codevelopment of only one major system, the Anglo-German FH-70 Howitzer (NBMR 39).[6]

Under the old system a codevelopment effort had to proceed through a maze of NATO committees before it could get off the ground. As was treated in Chapter 5 with regards to the Atlantic and V/STOL fighter projects, in practice, this tended to allow all NATO countries, regardless of whether they were financially participating in the program, or had their own competing program, to have a voice in how the weapon system should be developed. As a consequence, the time for required reaching a concensus for a given program made the method prohibitive. This contributed to the scrapping of codevelopment programs in favor of coproduction programs.[7] What codevelopment programs there were, took place outside the NATO framework as exemplified by the codeveloped Anglo-French Jaguar, Martel, Gazelle and Lynx or the Franco-German HOT, Milan, Roland and Alpha Jet, or the American-German MBT-70 and AVS projects. For several among these, and such coproduction programs as NATO Hawk and NATO F-104G, the participating nations sought NATO auspices for programs, if at all, only after the systems had been developed.

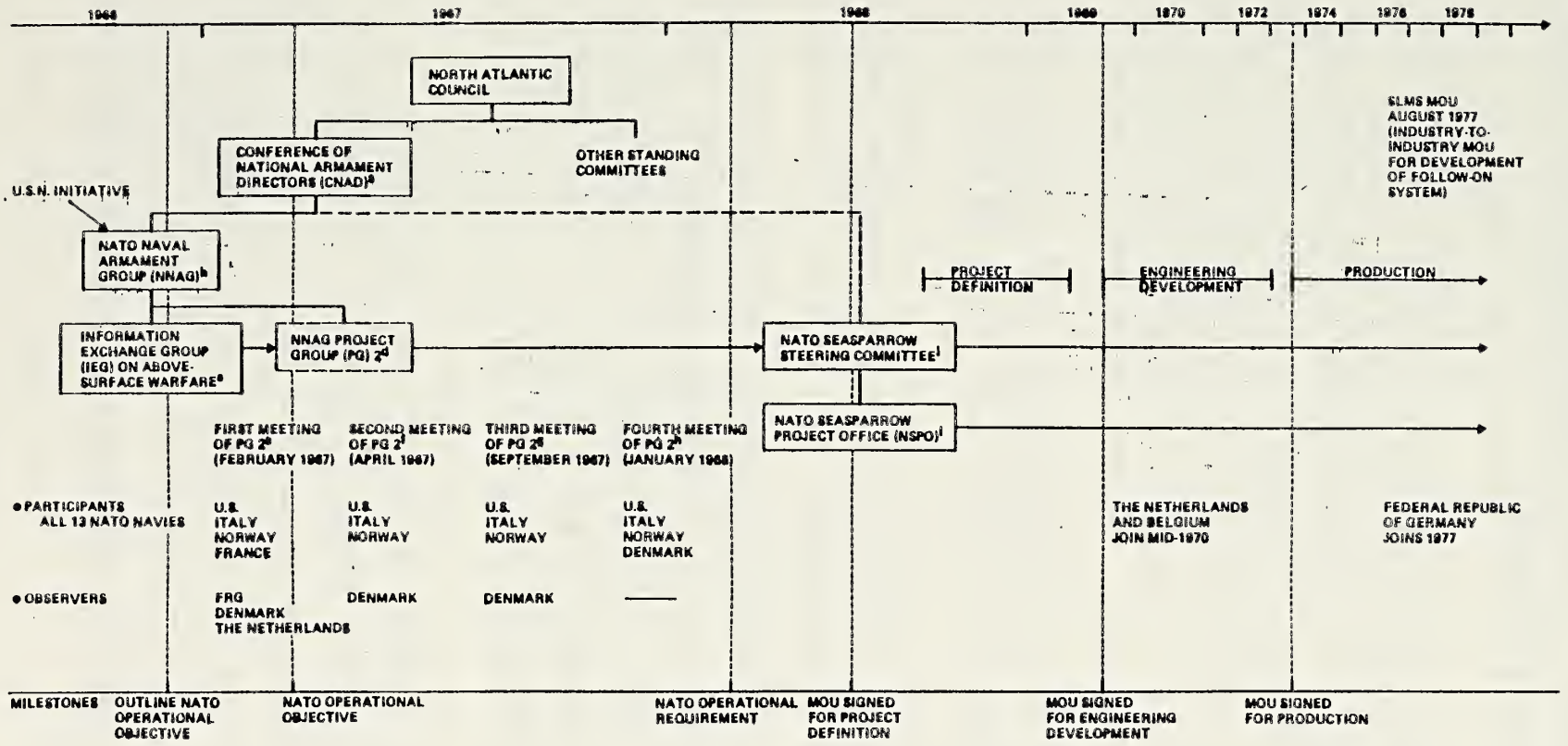
NATO Seasparrow, as such, was to become a test case for the validity of the new procedures that were set up in late 1966/early 1967. The only prerequisite for cooperative projects under the newly established procedures was that there be mutual agreement among any 2 or more countries choosing to

participate as to the management, cost-sharing, and end products of the program, prior to moving forward.[8] Unanimity among all 'interested' nations was no longer required only among the 'engaged' nations.

Therefore, unlike two of the other military projects treated in this chapter - the MBT-70 and the Mallard communication system - the nations participating in the Seasparrow opted to utilize NATO's organization and procedures for collaboration, instead of working outside of them.

Consequently, in 1967, the U.S. proposed several candidates to the CNAD's NATO Naval Armaments Group (NNAG) for cooperative development ventures. One of these was a surface ship shelf-defense missile system, to counter the recognized anti-ship missile (ASM) threat, one to be built around the Sparrow 3 AIM-7E air-to-air missile. Seven countries expressed an interest. Soon this was reduced to four engaged nations —Italy, France and Norway, along with the U.S. which —were represented on a project group under the auspices of the NATO Naval Armaments Group (NNAG) - the NNAG's Project Group 2.[9] The FRG, Denmark, and the Netherlands participated as observers only and thereby faced a one year deadline on joining in as engaged nations (i.e. funding and voting) or dropping out altogether. The project group was supported in its work by the U.S. Navy.[10]

At the first meeting of NNAG Project Group 2, held in February, 1967, preliminary agreement on the system configuration, a cost-sharing formula, and a management approach, was reached. The agreed to configuration, previously designated the Improved PDSMS, was based on the U.S.N.'s experience with the existing Basic Point Defense Surface Missile System (BPDSMS) and the follow-on study on an Advanced PDSMS, one which met the size and weight constraints of



[a] AC/259; U.S. member is the Under Secretary of Defense (Research and Engineering), Pentagon, Washington, D.C., Dr. William J. Perry (October 1979). The permanent NAD representative (NADREP) is the Director, Armaments and Standardization Division, U.S. Mission to NATO, Brussels, Belgium, Col. Daniel K. Malone (USA, October 1979).

[b] AC/141; U.S. member is Director, Tactical Air, Surface, and EW Development Division, Office of Research, Development, Test and Evaluation, Office of Chief of Naval Operations, Pentagon, Washington, D.C., RADM Frederick G. Fellowes (October 1979).

[c] One of six permanent NNAG IEG's.

[d] Project Group 2 relied heavily on the support of the USN's Point Defense Systems Program Office, Naval Ordnance Command, Washington, D.C.

[e] Three of the four nations participating came to preliminary agreement on the system configuration, a cost-sharing formula, and a management approach. France elected not to participate.

[f] The three participants made national commitments to join the program and agreed that the U.S. firm, Raytheon, was the logical choice for prime contractor.

[g] Cost estimates were submitted by Raytheon. A draft program management plan and the MOU were submitted to the Project Group for review.

[h] Denmark, the only remaining observer, elected to join. Complete agreement was reached by all four engaged nations.

[i] The U.S. and Norway signed an MOU on June 7, 1968, thereby obtaining NATO project status. The project office was staffed in Washington, D.C., and the first Steering Committee meeting was scheduled. Italy and Denmark signed several weeks later. The Naval Ordnance Command in Washington, D.C. simultaneously let a 6-month contract to Raytheon for project definition.

Nato Seasparrow Surface Missile System (NSSMS) and the NATO Acquisition Process

all countries concerned. The Improved PDSMS provided a major improvement over any existing self-defense SAM system.[11]

By the second meeting in April 1967, the U.S., Italy, and Norway indicated that they were ready to move forward by making national commitments to participate in the program. Three countries, the Netherlands, the FRG, and France (the latter two were considering going ahead with their own national programs), had decided not to go along and thereby dropped out, while Denmark opted to remain as an observer. The three participating countries also agreed that Raytheon would be the most suitable prime contractor, due to its role in the development of both the AIM-7 Sparrow and the Basic PDSMS systems.

At the third meeting of the NNAG Project Group 2, in September 1967, Raytheon introduced its tentative cost estimate for the project. This estimate permitted the countries to more realistically plan their Seasparrow force structure. In addition, a draft of the program management plan and the MOU were submitted for review. Also, the program had in the meantime received additional impetus from the sinking of the Elath - a timely reminder of the vulnerability of surface ships to missile attack.

The fourth and final meeting of the project group took place during January, 1968. At this point Denmark decided to join in as a full participant. The meeting concluded with complete agreement by the four nations on virtually all facets of the program and the recommendation that it proceed into funded development as soon as two or more nations signed the MOU. The four nations launching the joint engineering development project were Denmark, Italy, Norway and the U.S.[12]

During the four NNAG project group meetings, a recurrent pattern surfaced. NATO's three medium powers, France, the FRG, and the UK once again went their own way, uninterested in joining in as a minor participant in a project wherein U.S. government and industry were in the dominant role. However, their preferred alternative of collaboration on an equity basis with one of the other two medium powers was not resorted to either, since all three supported their own competing designs for a system wherein the investment and sales base required did not necessarily represent an insurmountable obstacle.

Representative of the fluidity of both membership and national orders in such ventures, as we will shortly see, there were to follow both order reductions and increases, and the taking on of new participants once the project was underway (though amazingly enough, there were to be no drop outs).

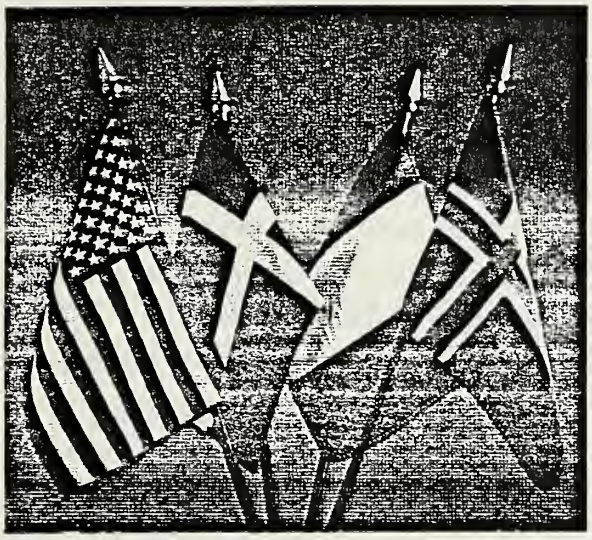
Underlying the formal concensus formation process within the NATO Naval Armament Group (NNAG) outlined above whereby the goernment consortium was neatly stitched together, was the support provided by the counterpart industrial consortium led by Raytheon. From among the three European partners the support of the Norwegian firm, Kongsberg Vapenfabrikk (KV), was especially critical in: 1) tying in the Norwegian Navy as the primary European advocate of the joint project and; consequently , 2) the Norwegian Navy's providing a steady guiding hand in assisting the U.S.N. with the threading of the source selection needle. Source selection becomes a very delicate undertaking in these joint projects wherein it is necessary to designate a contracting team early in the project and thereby avoid a drawn-out (and often counterproductive) competition in line with the U.S. Governments dogmatic and highly structured approach to competition.

2. Organizing the Government Consortium and the ED Competition

With the U.S., Norway, Italy, and Denmark having substantially agreed on the program management, cost-sharing, weapon system configuration, and schedule during their intermittent NNAG project group meetings between February, 1967 and January, 1968, it took another five months to obtain signatures on the MOU governing program implementation. Once the MOU was signed by any two of the nations, in this case the U.S. and Norway on June 7, 1968, the program was endorsed as an official NATO Project. Denmark and Italy were to sign several weeks later. The form and substance of the program remained essentially unchanged after the January, 1968 meeting.[13]

A. A Clean Chain of Command

Unlike many of the other joint programs covered in this paper, there is a single line of authority for the NSSMS. Under the NATO Seasparrow Project Steering Committee (NSPSC), acting as the board of directors, comes a single program manager. The program manager heads up the NATO Seasparrow Project Office (NSPO), located in Washington, D.C.,[14] which operates with the administrative support of the Naval Sea Systems Command (previously the U.S. Naval Ordnance Command). The U.S. Naval Sea Systems Command contracts with the single prime contractor on behalf of the NSPO. This prime contractor is, in turn, responsible for the subcontractors located in the various participating countries. Thus, there is a clean chain of command extending down from the international Steering Committee to an integrated international organization, the NSPO, which has operational direction and authority as well as detailed management responsibilities, down to the prime contractor through a well-defined contractor interface. As forthe prime contractor's relationship with the governm



THE ORIGINAL STEERING COMMITTEE

The NATO *Seasparrow* Project Steering Committee (NSPSC) was established under the guidelines of the Memorandum of Understanding, to coordinate cooperative action between the NATO countries. The committee was formed with one member from each of the participating countries with meetings held quarterly, or whenever required. The NSPSC establishes program policy and is responsible for the approval of total development and production contracts, schedules costs and configuration control.









Rear Admiral Immanual B. Rodholm, the Danish member of the NATO *Seasparrow* Steering Committee, has been the Deputy, Chief-of-Staff, Logistics in the Defense Command since 1974. Past assignments have included the US Shipbuilding Liaison Office in Rome, Flag Officer in Denmark, Plans & Intelligence of COMNAVBALTAP and the Danish Naval Staff.

General Sverre L. B. Hamre, presently the Chief of Defense of the Norwegian Armed Forces was the first Norwegian member of the NATO *Seasparrow* Steering Committee. From 1958 to 1962, he served on the staff of the NATO Standing Group in Washington, D. C. In 1975 General Hamre was relieved as a Steering Committee member when he assumed command of the Allied Forces North Norway.

Rear Admiral Mark W. Woods, presently retired from active duty, was the Chairman of NATO *Seasparrow* Steering Committee. He was Commander, Naval Ordnance Systems Command, Washington, D.C. His past assignments include command of the TERRIER guided missile frigate USS Farragut, Executive Officer and Deputy Director of the U.S. Naval Ship Missile Systems Engineering Station, Port Hueneme, California.

Captain Legnaioli, Italian member of the NATO *Seasparrow* Steering Committee, received extensive practical and academic training during his naval career. A graduate of the Naval Academy at Leghorn, he has studied artillery and missiles in both Italy and the US. In 1967, he was assigned to the Naval General Office as Chief of Artillery and Missiles. Since 1971, he has worked in industry as an Operative and Technical expert in Naval Weapon Systems.

Ten Years of International Cooperation & Progress

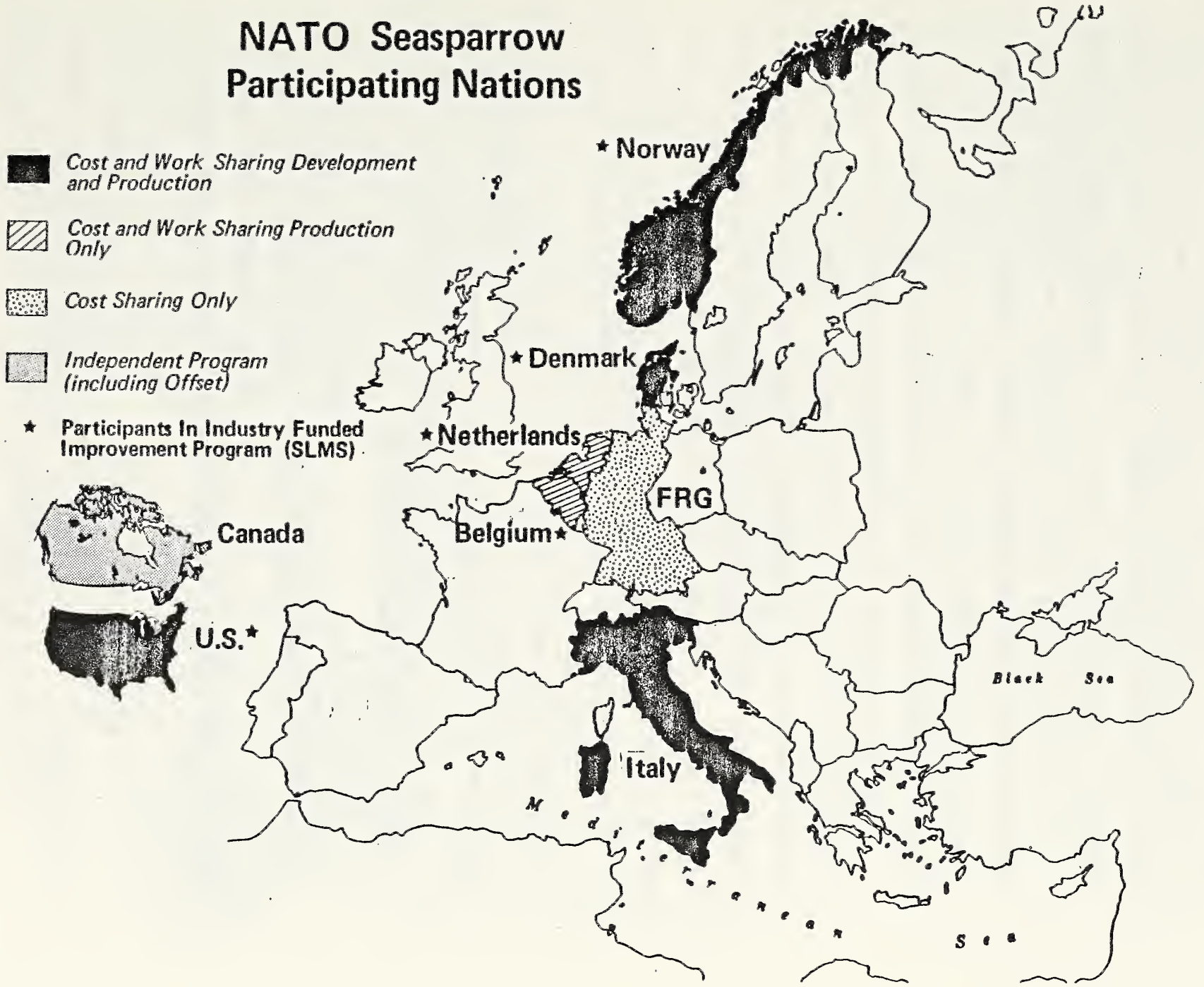
Ten years ago a major threat was recognized by several NATO member nations as a common concern to the ships of their respective navies should they become engaged in defense of the NATO Alliance so vital to the free world. Accordingly a unique agreement was reached to undertake the cooperative development and production of an advanced shipboard defense system called NATO *Seasparrow*. Subsequently seven nations signed a Memorandum of Understanding to Participate in this endeavor. The recognized success of this project owes much to the dedication of the founding fathers — to the original Steering Committee and their capable successors, and to the high degree of skill, enthusiasm and integrity found at all levels of the industrial team on both sides of the Atlantic. For everyone involved it was an enriching exchange of cultural and technological expertise. Truly a fine example of international cooperation. Because the people worked well together — their equipment is working well together and we are all a little bit safer.

tium, the contracting framework was that of normal DoD contracting, i.e. 'business as usual,' following ASPR, CAS, and receiving all its money from a U.S.N. account.

The systems, however, are delivered to the non-U.S. participants through direct commercial sales channels. Though sales to third parties (e.g., Japan and Spain) are through regular FMS channels, sales to NATO participants are not offically FMS. Although a DD250 is signed off by a USN inspector and used for billing purposes (the U.S. Navy acting as agent for the other participants), the U.S.N. only takes delivery of those systems destined for itself or non-participants. For NATO participants shipment is made directly to each Navy's designated forwarding agent.

Given the origins of the weapon system selected by the NNAG project group participants and the size of national requirements, the assumption of the role of pilot state by one nation, the U.S., is not surprising. As we saw in the Introduction to Part II, and Chapters 5, 7 and 8 though, this course is not always the one followed in setting up a transnational venture wherein exists a dual consortium of buying governments and selling industries. In the early 60's NATO project management and contracting choice centered on the two approaches adopted for the NATO Atlantic and the NATO Hawk projects. During the 70's the same issue was focused on two other projects, that of the Alpha Jet versus that for the MRCA Tornado. The NSSMS approach to NATO contracting and project management was essentially the same as that followed for the Atlantic and Alpha Jet projects, i.e., that of having one nation's government and industry (France in the case of these two projects) assume the pilot (or agent) role, and thereby opting to operate through that nation's defense contracting structure. Though this approach offers the advantage of greater

NATO Seasparrow
Participating Nations



efficiency, equity is somewhat diminished. Where considerations of equity prevailed, as with the Hawk and Tornado projects the nations moved outside of the national defense contracting environment and established a NATO subsidiary body, a NATO Production and Logistics Organization (NPLO). This entails however, the building up of a new contracting and project management framework, unique to that project.

B. The NSSMS Project Steering Committee

The highest level of authority for the NSSMS project is the NATO Seasparrow Project Steering Committee, consisting of one representative from each participating country. Nations joining after the signing of the MOU have had to be accepted by a unanimous vote of all members. The NSPSC has retained the responsibility for management, finance, and technical decisions in accordance with the MOU. Since decisions in matters of technical as well as financial content for the NSSMS are so reserved, the NATO Seasparrow Project Office (NSPO) was established outside of the normal U.S. Naval Sea Systems Command structure, being directly responsible to the Steering Committee and representing it in its day-to-day operations, serving as its working staff.

The continuity of key U.S. personnel has been singled out as a significantly contributing factor to the smooth running of the program[15]. This was particularly important during the early years with Captain Stanley Counts serving as Project Manager of the NSSMS until October, 1970, and then becoming the U. S. representative on the Steering Committee, as Rear Admiral Counts, upon leaving the prior post.[16]

In July 1968, one month after the official activation of the NSPO and the award of the definition phase contract to Raytheon, the Steering Committee was convened

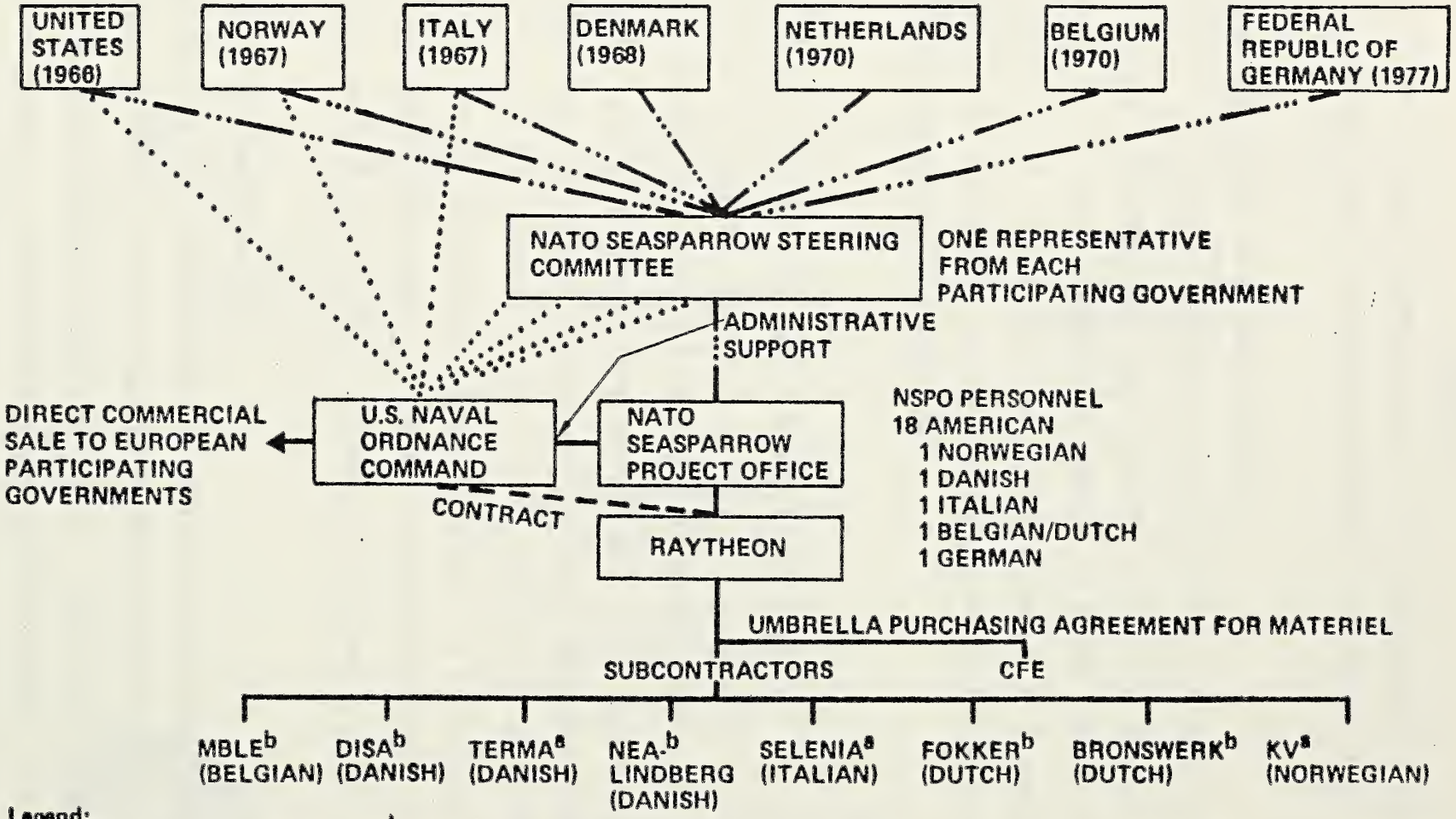
in Washington for the first of its quarterly meetings. This meeting was largely concerned with organizational questions. The nations agreed that all specification, schedule, and cost matters involving the NSSMS would require unanimous consent on the Steering Committee. Other decisions would be settled on a weighted majority vote basis, according to each government's funding share.[17] Subsumed in this unanimous vote requirement involving specification was another reportedly unique aspect of the program, at least as far as the U.S. is concerned. Configuration control rested completely in the Steering Committee.[18]

Raytheon's NSSMS assistant Project Manager for International Operations, Thomas E. Peterson, attributes the Steering Committee's effective decision-making authority and executive direction to the commitment of the participants, their willingness to compromise, and their detailed comprehension of the program, which, in turn, could be projected through a clean chain of command. Raytheon's Thomas Peterson further added for clarification, "The Steering Committee's role (a la NSSMS) is one of a Project Manager (directing body)" . . . vested, among other things, with Configuration Control. "The F-16 Steering Committee role, for comparison, is that of staff function serving as an advisory body only--no direct line of management into the consortium program."[19]

C. The NSSMS Project Office

The NATO Seasparrow Project Office (NSPO) was activated informally in April, 1968, and staffing was begun in anticipation of the signing of the MOU. When the MOU was signed two months later on June 7, by the United States and Norway, the NSSMS Project received official NATO sanction and the NSPO was officially opened. A gradual evolution took place over the following months during which the NSPO staff took control of the recently begun Contract Definition phase. During this learning process the NSPO was heavily dependent

NATO Seasparrow Project Management



Legend:

- Policy
- Management
- Contractual
- Administrative support
- Funding

Funding:

[a] Participated in both engineering development and sole source production.

[b] Participated in sole source production only.

upon the active participation of APL, Vitro Corp., and especially the U.S. Naval Ordnance Command. Once operating, the NSPO has continued to be dependent on the administrative support of the U.S. Naval Ordnance Command, as well as the support of the naval offices among the Participating Governments which have assisted the NSPO in reflecting the best interests of all members of the consortium.[20]

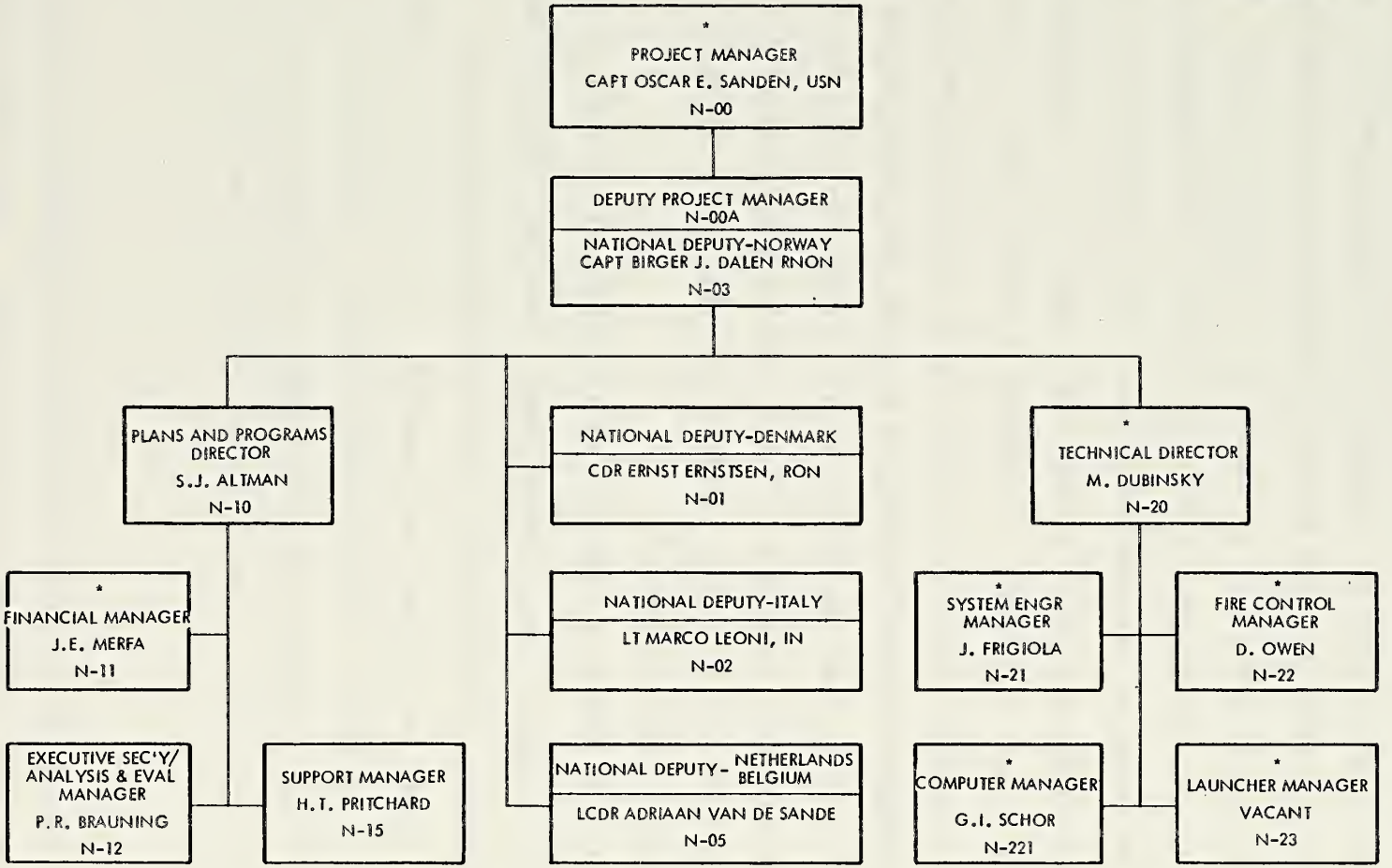
Composition of the NSPO staff roughly reflected the national financial commitments as they stood at that time, with the U.S. providing 18 of the 21 staff members as of mid-1969, including the program manager, a U.S. Navy Captain.[21] Norway, the next largest customer at that time,[22] provided the deputy program manager. Denmark and Italy each furnish one officer as subsystem managers. When the Netherlands and Belgium joined the program in May and June, 1970, they collectively provided one additional officer, bringing the non-U.S. contingent up to four. These officers also have direct access to program manager as national deputies for their respective governments.

D. The Enginering Development Competition

In October 1968, the Contract Definition (CD) report was delivered to the NSPO. The NSPO and the participating navies then assembled an evaluation team to study the report. As the evaluation proceeded, it became apparent to all on the team that the equipment defined by Raytheon's CD report was too big, too costly, and too limited in operational capabilities to warrant proceeding directly to an engineering development contract.[23]

At the Steering Committee's next quarterly meeting, in December, 1968, in Washington, it received the recommendations of the Project Manager concerning

NATO SEASPARROW PROJECT OFFICE



* UNITED STATES NSSMS OFFICE/DUAL FUNCTION (PMS-404-60)

the CD report. Instead of the original plan, the Project Manager's report, unanimously supported by the evaluation team, recommended resorting to competitive bidding for the Engineering Development contract. So, the Steering Committee directed the Project Manager to write the necessary baseline specification and to advertise for competitive bids. The specification was written in draft form prior to the departure of the representatives of the European navies. The specification was published in February, 1969, and, shortly thereafter, some 14 U.S. companies[24] were invited to submit proposals. Proposals were due by May 15 at the Naval Ordnance Command. The firms bidding for an engineering development contract for the NSSMS were still bidding on a system that would use the Raytheon Sparrow missile (and, therefore, also be similar to the U.S.N.'s Basic PDSMS in this respect), but one which would involve the development of new radar, fire control, and launching systems, each based on a new design and performance specification.[25]

The detailed proposals submitted were received by the NSPO in June, 1969, and an evaluation began. The evaluation team, numbering almost 100 evaluators, again consisted of representatives of the four participating navies. The evaluation team studied the proposals and measured each individually against the NSPO originated specification. Review of the proposals, evaluation, and the subsequent negotiations intended to provide acceptable equipment at a fair price, culminated in the report to the Steering Committee in the latter part of the summer of 1969.[26]

In September the Steering Committee met in Washington, to receive the reports of the Evaluation Board and the Project Manager. The Steering Committee then directed that the Engineering Development contract be awarded to Raytheon by the

Naval Ordnance Command; the contract being signed immediately therafter, the same month, September 1969, for some $23 million.[27]

3. Joint Development and Production

A. The Initial Plan

The engineering development of the system was to involve the prime contractor Raytheon, subcontracting certain elements of the development effort to one Norwegian, one Danish, and one Italian firm. This was to be followed by two years of a sole source production effort with Raytheon still acting as the prime contractor, but expanding the industrial consortium to include firms from any nations that had joined the project after engineering development had started.

This two-year period was then, according to the original plan, to be followed by two or more production runs - each Participating Government having received a complete production data package in the interim, which would have allowed them to make the necessary contractual arrangements for follow-on production in their own countries, on either an individual or collective basis. A plan was worked out by the NSPO to maintain a central management organization to assist in configuration control during the follow-on independent national production phase and for the operational life of the system.[28]

B. Cost and Work Sharing Arrangements

Total R&D costs for the project were $35 million[29] of which 83.6% ($29.314 million) was footed by the U.S. The cost-sharing formula, by which the participants contributed to the total cost of development, was figured on a proportional basis according to the number of systems each committed to procure through the first three years of production. The first two years were to involve sole source production with Raytheon as the prime, while the third year was to be the first year of separate national production runs. This three-year span was selected to

avoid the complexities of endless updating of the cost-sharing figures as the national plans changed over the years. Nations joining the consortium after engineering development had started still paid their proportionate share of development costs. Any increase in the number of systems procured would cause recalculation of development shares, retroactive to the start of the program. But if fewer systems than anticipated were bought by a certain country, it could not get any of its money back.[30]

Provision was also made for calculating cost-sharing on a subsystem basis - missile, fire control system, and launcher - for those countries desiring only partial systems.[31] Further breakout was not allowed due to the complexity of calculating costs, and the impact of such fragmentation on program management.[32]

As it turned out, actual national purchases were different from those planned for all the participants. The U.S. and Norway drastically reduced planned procurements, while Italy and Denmark increased theirs slightly. After the Netherlands came in, it later trebled its order.

As prime contractor, Raytheon not only had responsibility for management of the cooperative development effort and the total system, but for fulfilling the balance of payments requirements through providing compensating work to within at least ± 25% of the individual national shares of development costs, and later of production costs. These BOP/work sharing constraints necessitated early planning by the prime contractor as well as the NSPO. As a consequence, long before formal program approval, a tentative network of contractual arrangements had been worked out between the U.S. prime contractor and its subcontractors in

each of the other countries.[33] And since the distribution of contractual effort required a long lead time, the ruling on compensating expenditures in each country could not apply for engineering development to nations that joined late, such as the Netherlands and Belgium, both of whom joined in 1970.

With one exception, all equipment was either designed by Raytheon (and later built to print) or designed by one of the European subcontractors.[34] The program was able to draw upon areas in which each European firm had special technical capabilities. On a more general level, the electronics industry is particularly well-suited for these transatlantic projects, especially those involving the smaller national economies within the alliance, because of the limited capital required for start up and its suitability for production by smaller firms.[35] In addition, most of these European firms participating in the NSSMS project had been involved in several of the previously cited joint production projects with a high electronics content (e.g., the Hawk, Sidewinder, and Bullpup missile systems, and the NATO Air Defense Ground Environment (NADGE).

Two other points need to be mentioned regarding BOP constraints. First, the computation of offsetting expenditures for BOP purposes cuts off at the second tier of subcontracting. Second, the NSSMS arrangement, where Raytheon had total BOP responsibility, can again be contrasted with that of the much more complex F-16 program where such responsibility was pressed down to the U.S. subcontractor level as well.

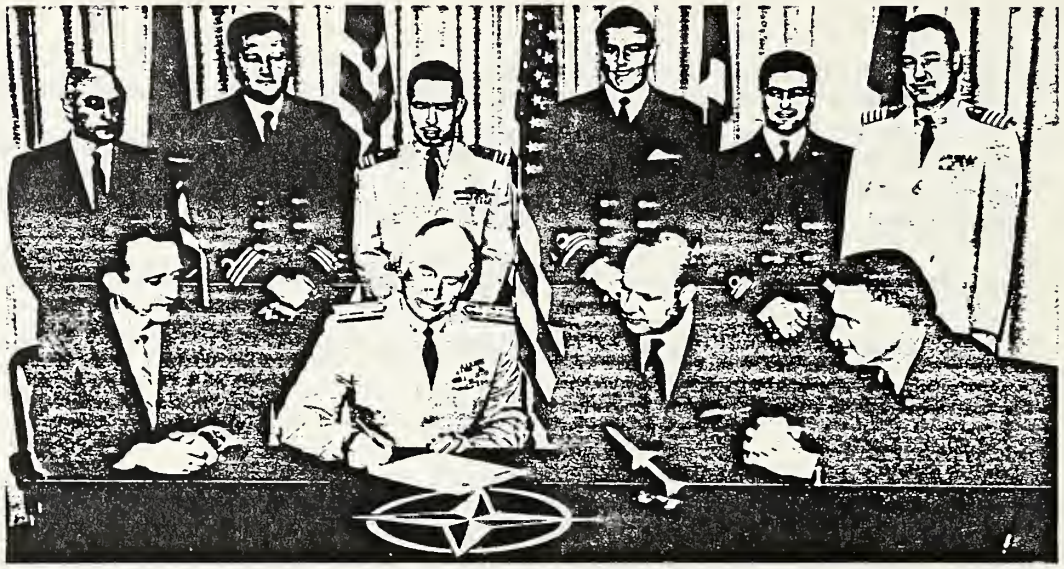
C. Engineering Development

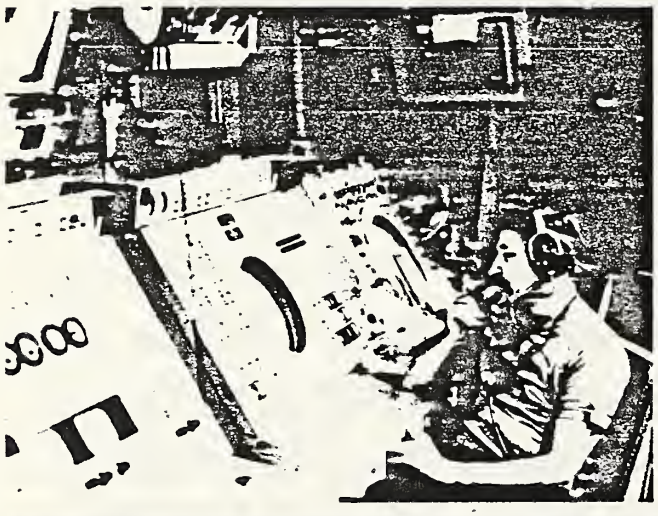
The Engineering Development (ED) phase of the NSSMS lasted approximately three and one-half years, starting in September, 1969. During this period three prototype systems were designed, built, and tested by Raytheon and evaluated on U.S.and Norwegian Navy ships. Engineering development was performed in

accordance with the design and performance specification written by the naval commands of the Participating Governments. The major accomplishment of the ED phase was its having brought together the divergent engineering and manufacturing disciplines of the U.S. and Europe to develop and produce well-integrated equipment without having to pay a premium with regard to cost, schedule, or performance.[36]

The three firms that responded to the IFB for ED were each eventually awarded subcontracts. The Norwegian firm, A/S Kongsberg Vapenfabrikk (KV), having developed a computer-operated fire control system for another weapon system, developed the fire control digital computers and radar pedestals.[37] The Danish firm, Terma Elektronisk Industri A/S, developed the radar microwave receiver, while the Italian firm, Selenia Industrie Elettroniche S.p.A., modified a previously developed monitoring system for use as the firing officer's display equipment.[38] These three contracts returned around $4 million in development work, or about 10% of the R&D effort.[39] (The Belgian and Dutch pro rata contribution to the 16.4% non-U.S. part of R&D costs could not be returned to their industries due to late entry.)

During 1972 and 1973, the NSSMS underwent evaluation on U.S.N. and Royal Norwegian Navy ships. The U.S.S. Downes (DE 1070) served as the platform for technical evaluation (TECHEVAL) and operational evaluation (OPEVAL). Contractor demonstration and U.S.N. OPEVAL began in October 1972 and was completed in March 1973. During TECHEVAL and OPEVAL tests, the system's performance was qualified by U.S. Navy men as impressive, and it was able to score direct hits and kills with an unusually high level of reliability.[40]





OCTOBER 1969—Signing the $23 million NATO Seasparrow contract is Rear Admiral Mark W. Woods, Commander, Naval Ordance Systems Command. Seated are (l. to r.) J. S. Walsh, Raytheon Program Manager, Adm. Woods, J. Reid, NAVORD, Dr. J. F. Shea, Raytheon. Standing are project office representatives from the participating countries: A. Abate, Raytheon, Cdr. F. Tonnessen, RNN, Lcdr. P. I. Bledsoe, USN, Lcdr. F. Andersen, RDN, Lt. A. Pescatori, IN, Capt. S. T. Counts, USN, NATO Seasparrow Project Manager.

USS Downes

NSSMS shipboard testing aboard the USS Downes produced successful TECHEVAL and OPEVAL results in the temperate waters adjacent to the U.S. mainland.

An innovation of the NSSMS program was the addition of an evaluation that was carried out by the Royal Norwegian Navy. The system was installed aboard the destroyer KNM Bergen in March, 1973. This evaluation tested the system in a far-northern environment, with the limiting conditions of ship size and geographical restrictions in which the Royal Norwegian Navy operates.[41]

D. Production

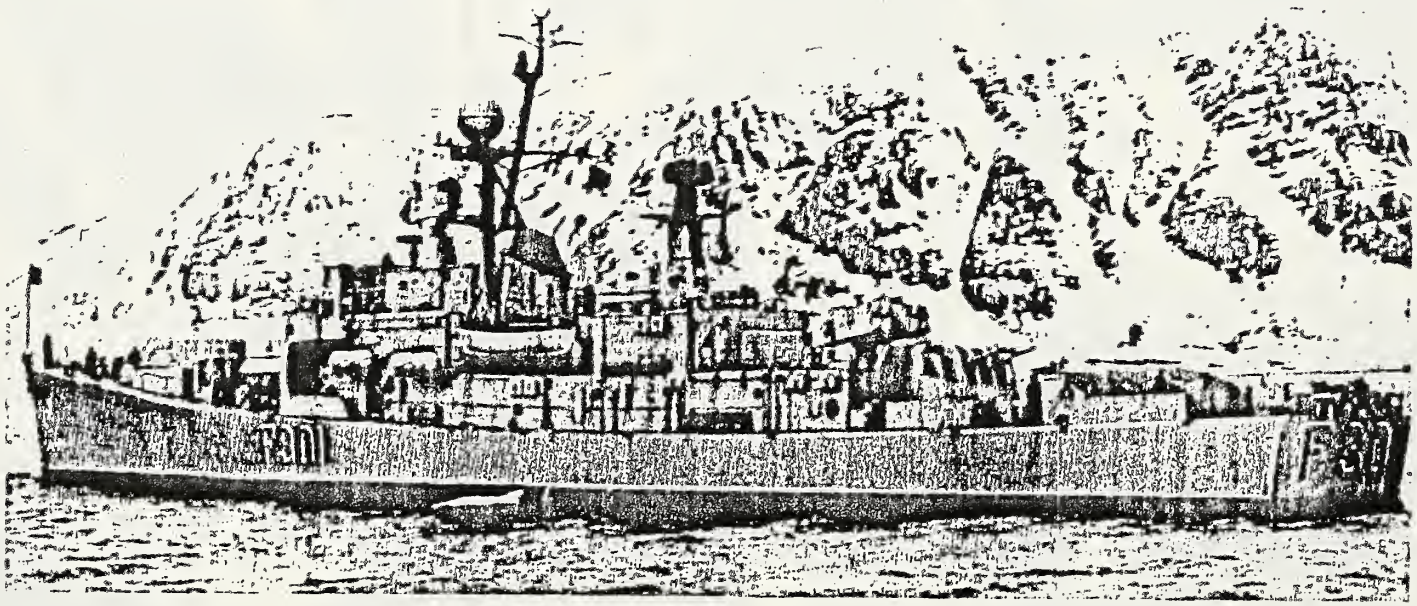
Originally, the two-year sole-source production phase was to begin concurrently with OPEVAL and TECHEVAL in 1972, but, at the insistence of the European participating governments, it was delayed until after successful OPEVAL. In August 1973, just short of four years after engineering development had begun, Raytheon signed the production contract with the U.S.Naval Sea Systems Command. Allowing time for subcontract negotiation and turn-on, production activity got off the ground in January, 1974. Production deliveries began in January 1975 with first deliveries going to the Netherlands followed by Norway, the U.S., Denmark, and Belgium later in the year. Deliveries began for Italy in early 1976 and for the FRG in mid-1978 - the FRG having joined the dual consortium at the governmental level only, in early 1977.[41]

As of early 1981, the original production distribution has been maintained with the exception of Selenia. Selenia was dropped in February, 1979 because of price. Selenia's part of the work package, the firing officer's console, was brought back to the U.S. Subsequently some of the work went back over to MBLE in Belgium, some up to Raytheon Canada (to count as offset toward a possible Canadian purchase) and some work was retained at Raytheon's Quincy, Mass. plant.

For the production phase, as previously stated, the industrial consortium expanded to involve greater European participation. In addition to U.S., Norwe-

KNM Bergen

The NSSMS engineering model tested aboard the Norwegian frigate KNM Bergen produced successful results in the colder environments where the Bergen normally operates.



gian, Danish and Italian firms, the production consortium also included Dutch and Belgian firms.

European Development and Production Responsibilities for the NSSMS

Company	Nation	Item(s)	Development	Production
MBLE	Belgium	printed circuit boards		X
DISA	Denmark	launcher pedestal		X
Terma[42]	Denmark	microwave receiver	X	X
NEA-Lindberg	Denmark	static frequency converter		X
Selenia	Italy	firing officer's console	X	
				(X)
Fokker	Netherlands	launcher rail, and director controller		X
Bronswerk	Netherlands	liquid cooler, electronic equipment		X
Kongsberg Vaapenfabrikk	Norway	director pedestal and digital computer	X	X

Raytheon's NSSMS Project Management office in Wayland, Mass. provides overall management and control for the effort while the Raytheon NSSMS European office in Copenhagen adapted the requirements to European methodology. Early on in the program, Raytheon had a team totalling 11 men in Europe representing subcontract management, manufacturing, quality assurance, and engineering. A Raytheon man was originally located in each of the eight subcontractor plants to provide on-the-spot assistance, and generally maintain close coordination and communication. The balance of 3 were located in the Copenhagen office. During the mid-70's the European team dwindled to one man, the Manager European office, Copenhagen. In addition to the residency arrangement, Raytheon provided technical, business, and commodity buy assistance from the Wayland and Copenhagen offices.

As previously stated, the original plan had been to break up the industrial consortium after 2 years of sole-source production and then proceed with independent national production programs. This, however, did not occur and all parties agreed to continue the program on the original single-source basis.

This led to a major increase in the BOP percentages of the European firms, well beyond the original constraint of at least 75% of originally planned expenditures being returned to a nation through industrial participation.

Balance of Payments Through November 1979

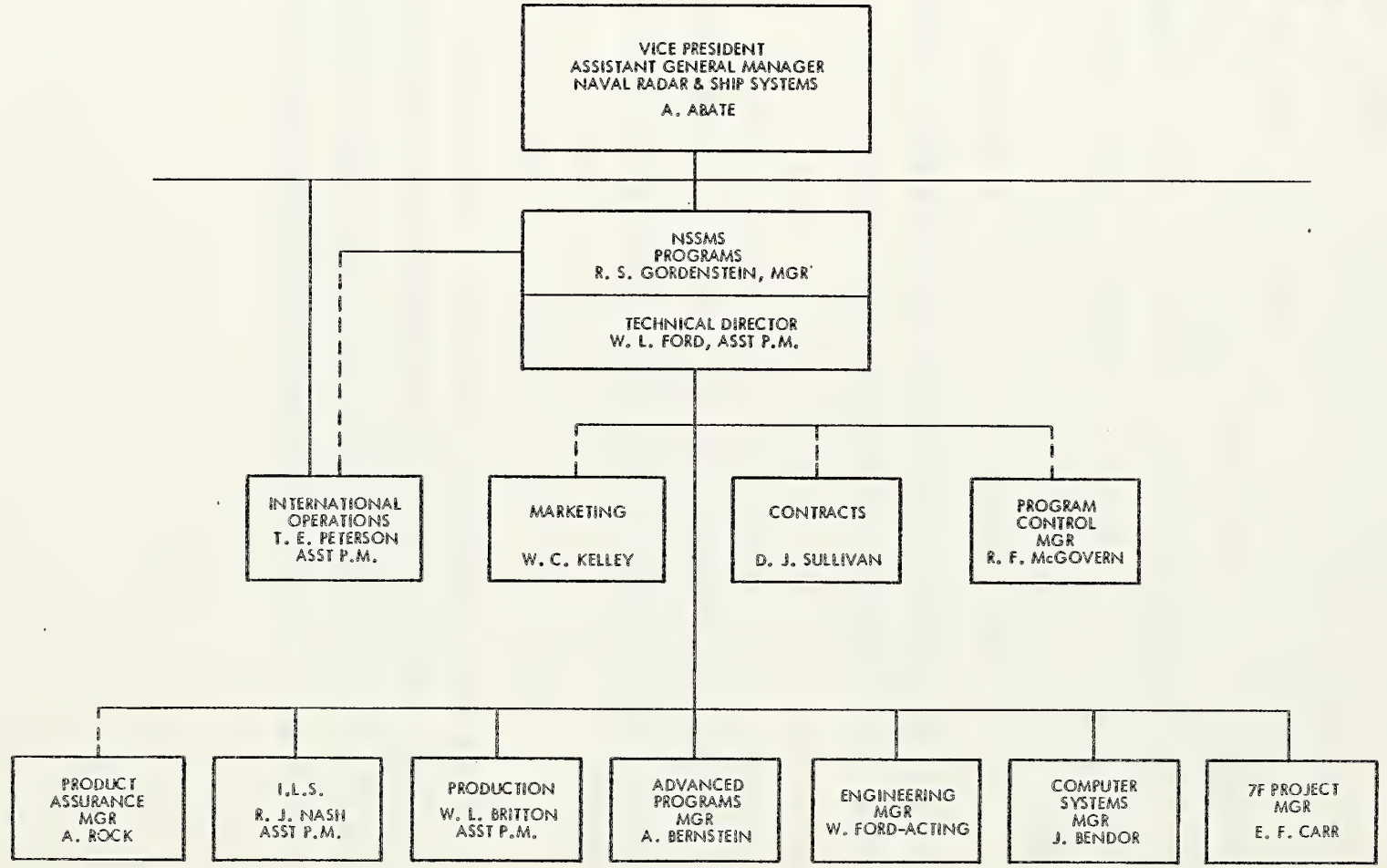
	Original % of BOP[43]	Current % of BOP[44]
Belgium	82	215
Denmark	77	156
Italy	100	150
The Netherlands	75	158[45]
Norway	90	184

Source: Thomas E. Peterson

After the FRG's order in 1977 all participants except for the FRG were in a plus position vis-a-vis BOP. The national orders among NATO participants were split at about 60% of the systems being for the U.S. Navy and 40% collectively for the European navies. As of the fall of 1979 the total contract value to Raytheon for the NSSMS was $300 million (excluding missiles). Within this amount the total value of national orders by the original European participants came to $79 million.

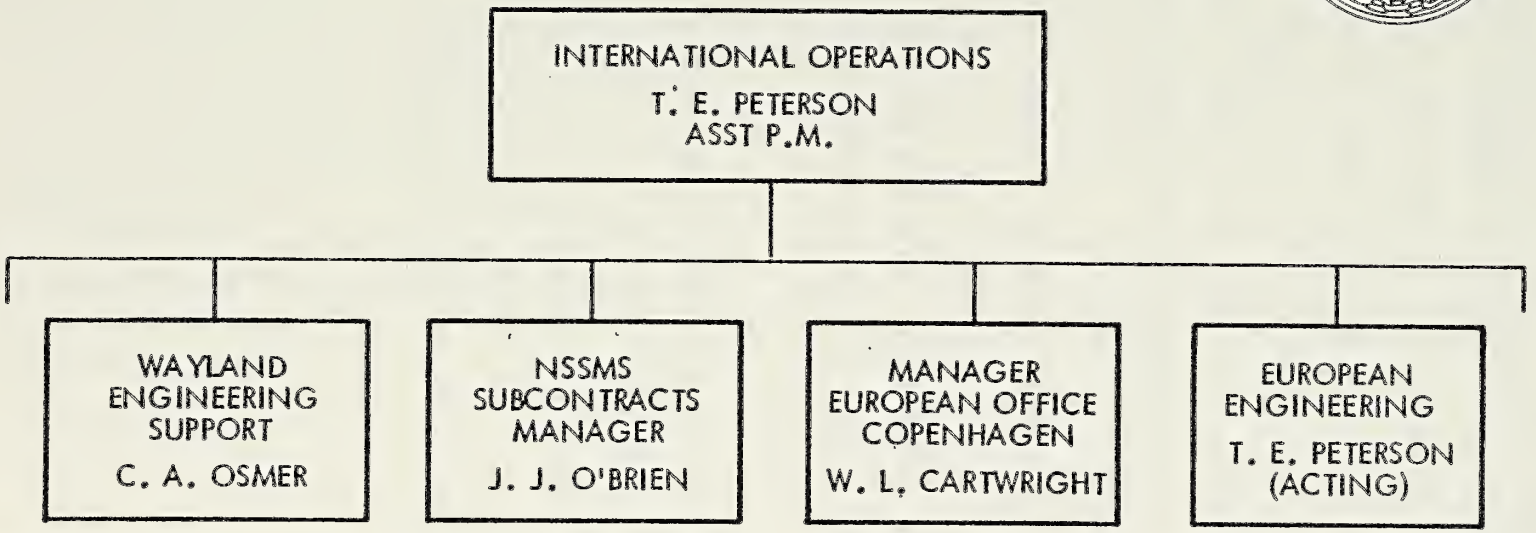
Even though offset obligations have been more than met for all European participants, seven of the eight original European sources have been maintained. Only Selenia has been dropped. Keeping this original team in tact has had to be justified purely on the economic merits of the situation. The USN people at

RAYTHEON NSSMS PMO ORG



RAYTHEON





SUBCONTRACTORS

BELGIUM	MBLE
DENMARK	DISA
	NEA-LINDBERG
	DANNEBROG/RADARTRONICS
ITALY	SELENIA
THE NETHERLANDS	FOKKER
	BRONSWERK
NORWAY	K.V.

VARIOUS DOMESTIC SUBCONTRACTORS

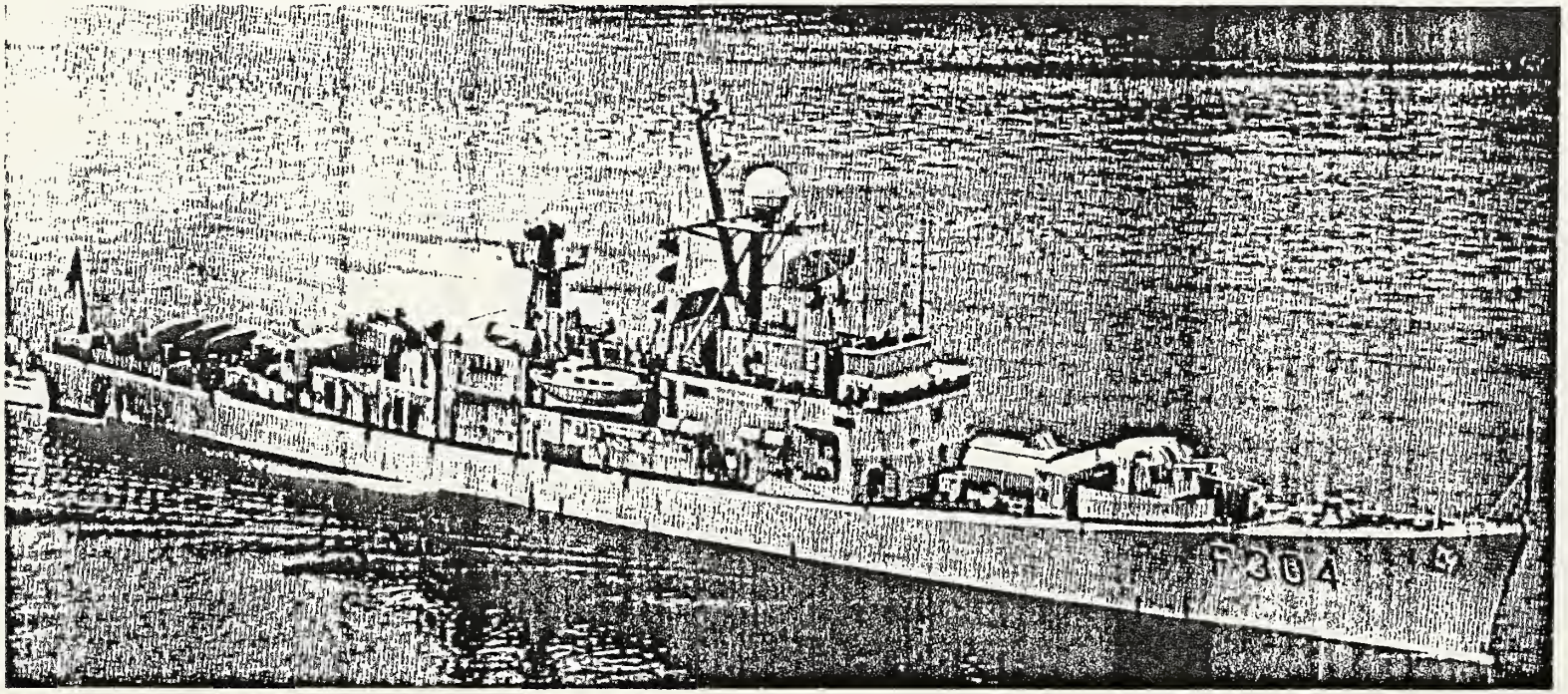
the NATO SPO have had no problem with the foreign sources. However, justifying maintenance of the status quo to those USN personnel and civil servants outside the project office has not gone as smoothly.[46] When a request for a quote on a new buy comes in from the Naval Sea Systems Command (for a new customer, the USN, or an add-on to the original order of one of the European participants), the program periodically has to get over the hurdle of justifying the European sole sources, since they're no longer required. The obvious point, that it is smart to continue with the Europeans, from both a political and marketing viewpoint, is not relevant. What does the trick are the economies of scale, the start-up costs being so far downstream. This in itself makes prospective U.S. sources non-competitive. And of course, back in 1973 there was a full fledged competition. With new buys coming in for quantities of five or ten systems, going out for alternate sources just can't be justified.[47]

	NSSMS Orders				
Country	Single Systems	Dual Systems[48]	FCS[49]	Transmitter	Launcher
U.S.[50]	31	51	Std		
Norway	6[51]	--	Std		
Italy	4	--	Std		
Denmark	1[52]	5	Std		
Netherlands	--	--	HSA	26	13
Belgium	--	--	HSA	4	4
FRG	--	--	HSA	13	7
Greece[53]	--	--	HSA	1	1
Spain	--	--	HSA	4	4
Japan	--	--	HSA	2	5
	42	56		50	34

The production effort was divided such that 51% of the production of hardware was done in Europe. The U.S. has kept its plus position with regards to BOP, because of third country sales and other funded production activity such as project management, logistics, installation, and systems integration and test-- the usual areas of responsibility falling to a prime contractor.[54]

Oslo Class *KNM Narvik*

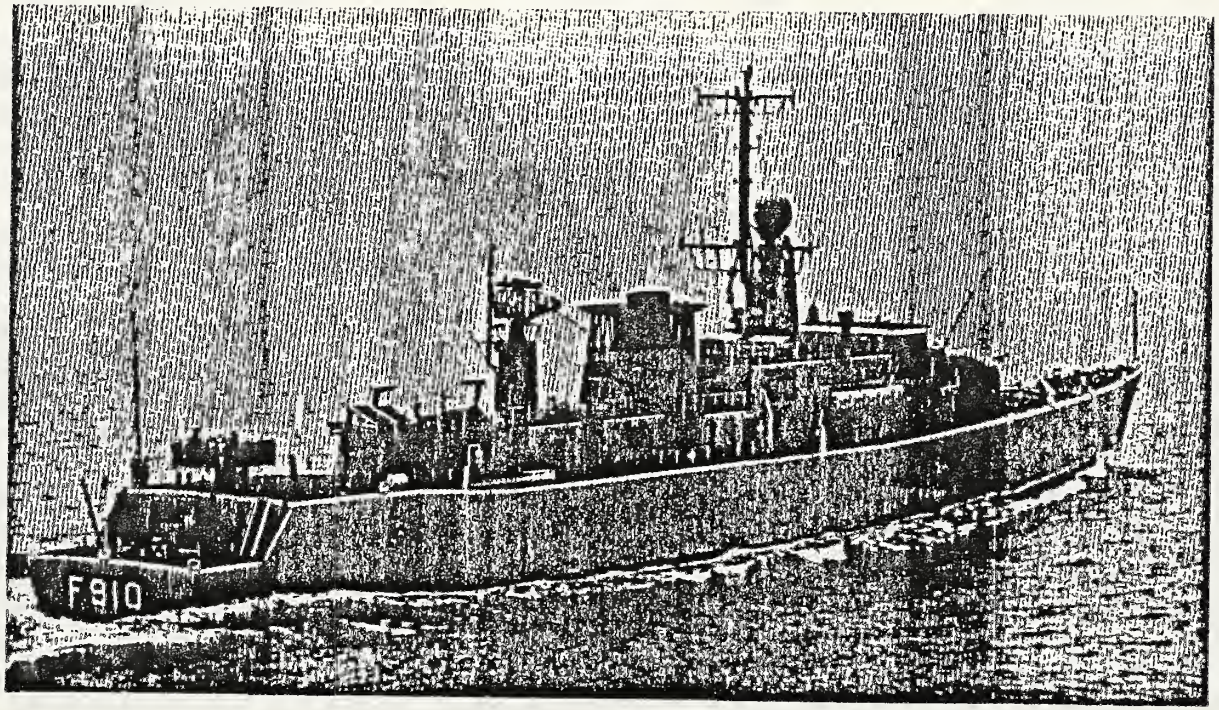
KNM Narvik was commissioned in 1966.



In addition to regular 2-4 FMS administrative fee, all non-participating nations that purchase the system must pay a 10% R&D recoupment fee on top of the Raytheon sales price, one that is passed on to the participating governments. If a prospective customer is also a NATO member, however, it has the option of applying for membership which would allow it to pay only a pro rata share of the original investment and no FMS administrative fee. The application must be voted on by the participating governments and accepted unanimously.

Since each year the price of the hardware is going up by around 10%, paying another 10% on top of this ever growing base is a much more expensive proposition. It is therefore, considerably cheaper for NATO members to join the project and pay only a share of historical costs. The FRG joined on this basis in 1977, sending a permanent representative to the SPO and placing one on the Steering Committee. Greece is currently considering membership, and in the interim is sitting in on the Steering Committee as an observer.

Royal Belgium Navy E-71 Class *Wielingen*
The E-71 frigate Wielingen, is the first class fully designed and constructed by the Belgian Navy. The Wielingen was built in Belgian yards by Boelwerf, Temse.



4. The Transnational Subcontract Management Effort

A significant element contributing to the NSSMS program's success was Raytheon's having been allowed the time to thoroughly plan the whole international subcontract management and procurement effort. Consequently, contrary to the myth spawned by the experiences of early collaborative projects, the program encountered no measurable cost increase attributable to the requirement that the industrial effort be multinational.

Unlike the much more complex F-16 coproduction effort, where the management of the numerous European subcontractors was a fractionated effort distributed among prime contractors (General Dynamics and Pratt & Whitney), and some 20-odd U.S. subcontractors, the NSSMS involved a smaller, more manageable number of European firms that were all first tier subs to Raytheon. This allowed Raytheon to centrally manage all of its subcontracts and minimize most problems impacting on cost. Under the heading of "International Subcontract Management Considerations" in his spring 1977 vue-foil presentation at Wright-Patterson AFB, Peterson summarized the major worries expressed when the Europeans were initially contacted by Raytheon to participate in NSSMS.
These considerations were:

- European industrial/technical capability;
- Industry/government/steering committee relationships;
- Concern for U.S. material procurement;
- Apprehension as to adequacy of supplied data package;
- Uncertainty over engineering changes;

- Familiarity with Q.A. and standardization procedures;
- Business controls;
- Imposition of ASPR requirements;
- Concurrency;
- Escalation
- Assistance,
  Residency,
  Commodity Buy,
  Technical Business;
- Communications.

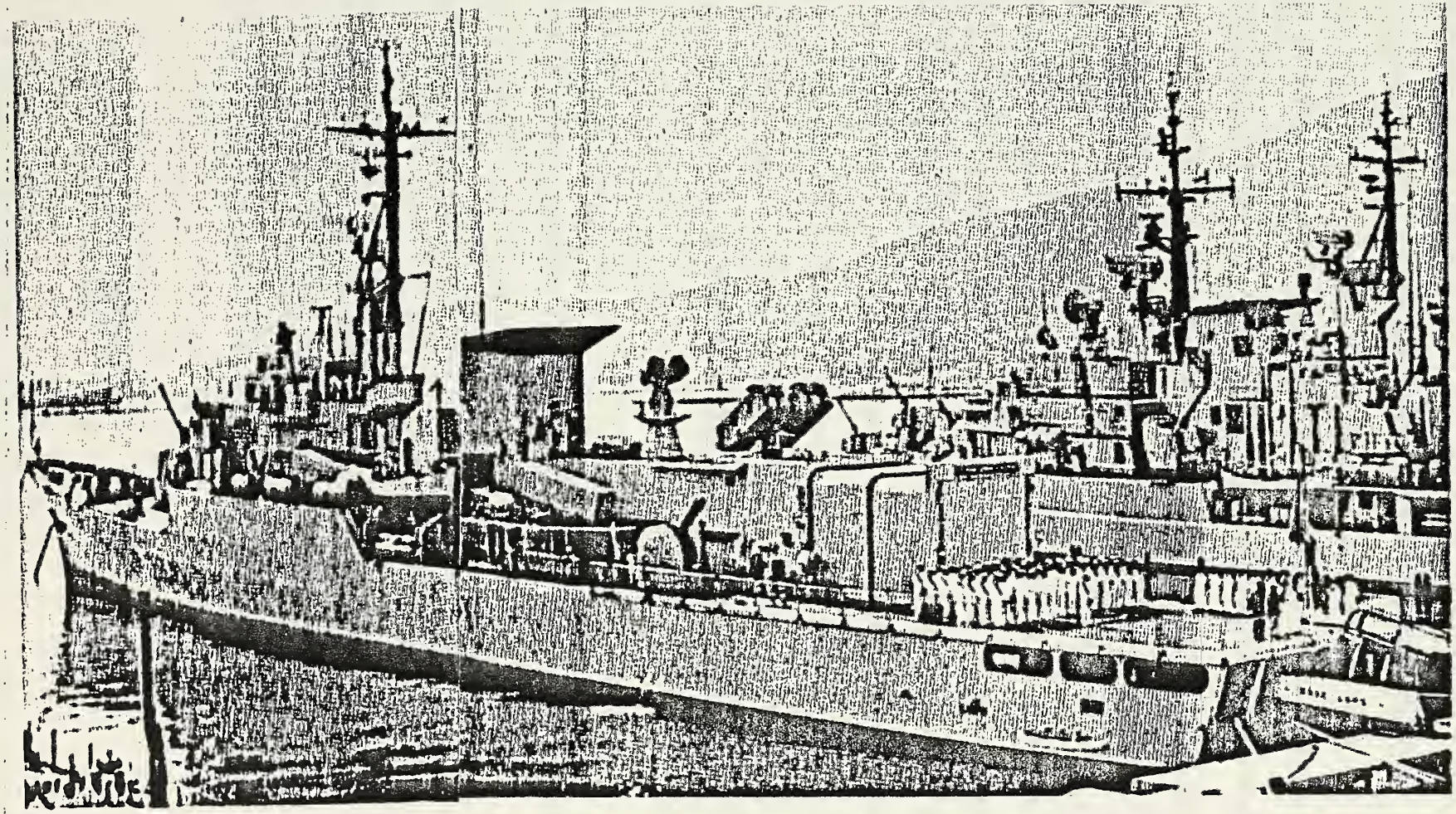
Peterson's commentary on the above issues in a letter to the author was a terse,

> I am pleased to report that each of these worries has been alleviated, and that the situation is, in fact, one of a joint international industrial team working in such a way as to make any efforts ... centered on the DoD and its RSI policy ...look juvenile.

In the way of further explanation on this latter point, Peterson stated,

> My comments ...when I made them, are more borne out of frustration than fact. It is my firm belief that left with only the requirement, industry will accommodate a multinational offset coproduction, or whatever you want to call it, to the satisfaction of international industry who in effect should be the only party to be pacified. It is the Government's zeal to manage this activity each step of the way that I consider unenlightened. . . .The U.S. government is so busy telling industry what to do, that it is not listening to what they want to do.

Peterson evidently feels that, in the achieving of an adequate balance between government and industry in their roles of encouraging and managing such collaborative projects, the weight should fall more heavily on the side of industry, with less reliance being placed on governmentally imposed schemes and direction. The NSSMS project provides us with an example of how government and industry have been able to work successfully in the past along these lines, while its follow-up, the Seasparrow Lightweight Missile System (SLMS) provides us another model of



Lupo Class *M.M. Lupo*
Commissioned in 1977, M.M. Lupo is named after the constellation Lupus (Wolf). Built by CNR, Rivo Trigoso, the M.M. Lupo is the first of four Lupo class ships.

how industry can go even further, in the future, in assuming responsibility for initiating and managing such transnational projects.

A. The Issues of Cost and Source Selection

In a 1971 report by Jack N. Behrman, prepared under contract for the U.S. Department of State, entitled Multinational Production Consortia: Lessons from NATO Experience, five projects were examined, one of which was Seasparrow. The other four included the Hawk, F-104G Starfighter, Sidewinder, and NADGE projects. From this rather limited data base Behrman compared their respective experiences in each of those aspects of a project over which agreement must be negotiated by the participating governments, while reaching a mutually acceptable tradeoff between efficiency and equity--a fundamental conflict. These aspects included:

- problem definition;
- system design, bidding, and procurement;
- financial commitments;
- balance of payments;
- allocation of production;
- company selection;
- costs and pricing;
- organization and management;
- technology transfer (dissemination and protection);
- development;
- taxes and duties;

- legal aspects, and;
- follow-on.

From among these areas two of Behrman's conclusions concerning the Seasparrow project--at that time still in engineering development--were refuted by Raytheon's NSSMS assistant Project Manager for International Operations, Thomas E. Peterson. First of all, under 'Allocation of Production,' Behrman cited the NSSMS as an example not only of the necessity of cooperation, but also the common problem of the extra costs involved in cooperative development.

> Cooperative development will probably be needed in mosts cases in the future to make certain there are equal possibilities to develop specialized production capabilities in each major new field. This move, however, merely pushes back one step the question of who specializes in what--decisions now made at the R&D stage. These decisions are not made easier by cooperative undertakings; they are, rather, much more difficult and tend to set a pattern of future costs that may be much higher than necessary--as evidenced by the allocation of development under the Seasparrow.[55]

In response, Mr. Peterson emphasized that not only had there been no discernable cost increase over a purely domestic project, but a number of key U.S.N. people have stated that European participation has meant that the cost of Seasparrow systems to the U.S. has actually been lower than would have otherwise been the case.

A second quote from Behrman's report cited the Seasparrow project as also being illustrative of the general problem of source selection.

> The Seasparrow program illustrates the difficulties created when companies are selected by governments as sole-source suppliers. Each then knows it is the only source for some piece of equipment; what it may not know is which piece. The prime contractor, or the consortium, may ask for bids from several potential suppliers, but as the various companies are selected, the few left know that they must be the source for remaining subsystems or pieces. Their bargaining power is enhanced, and difficulties arise in coming to a firm price--at least one reasonable in the sight of all governments. It is not in the

> interest of the government of the recalcitrant company to force a reduction in the company's bid.56

Although, as with the previous Behrman quote, this is a common problem faced in joint development projects, Raytheon's Mr. Peterson was again quick to point out that, to the contrary, the NATO Seasparrow project actually proves that such problems can be minimized or even avoided, and are not necessarily major obstacles to collaboration.

As previously covered, Raytheon was selected in 1969 by the four original Participating Government's after an engineering development competition with 13 other U.S. firms. Raytheon then selected 3 European firms to participate in engineering development, receiving in all about 10% of the work.

In 1973, in addition to continuing with these three, Raytheon selected another five European firms for the production phase. Within the slack provided by 75-125% BOP rule Raytheon was able to run an effective group wide competition, soliciting bids in each country for 2 to 4 times the amount of the required offset. Raytheon put together 7 or 8 collaborative production packages ranging from very high to very low European participation along with the corresponding price tags. In the end the Steering Committee selected a package in the middle ground, one in the range of an average of a 90-plus percent offset.

During source selection, Raytheon would ask the governments who they should talk to, specifying the required capabilities (which in the case of the national industries concerned were a good fit for the system); but in no case

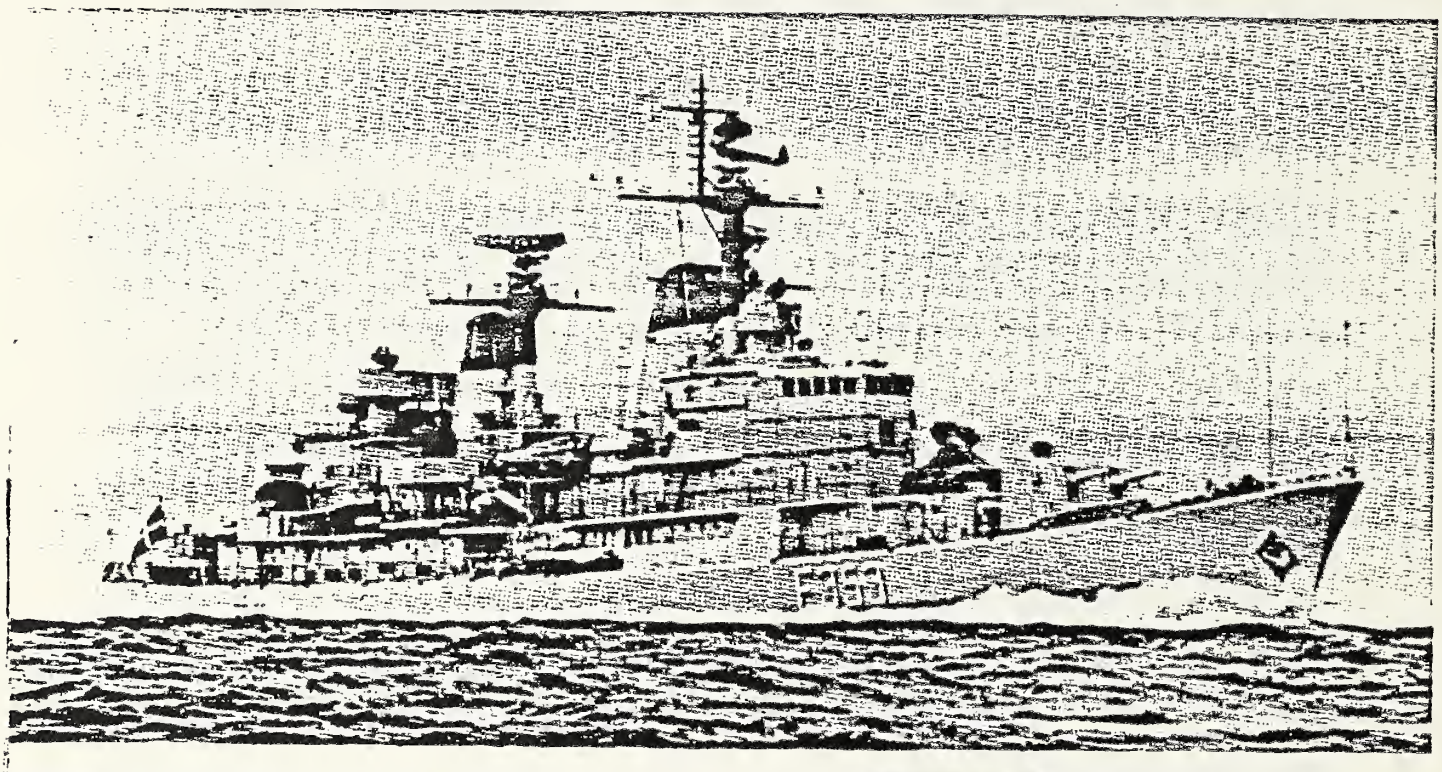
was Raytheon ever flat out directed by a government to a given source, although sometimes they were nudged or veered. In Norway, even though KV had been an obvious choice to be the Norwegian participant from the beginning, Raytheon selected KV's computer independently of this constraint. Even though there was only one case of an in-country competition (between Belgium's MBLE and ACEC[57]), Raytheon was able to maintain adequate leverage over source selection. In addition Raytheon obtained quotes from both U.S. and European firms for subcontract items, with all European quotes having been compared to U.S. quotes.

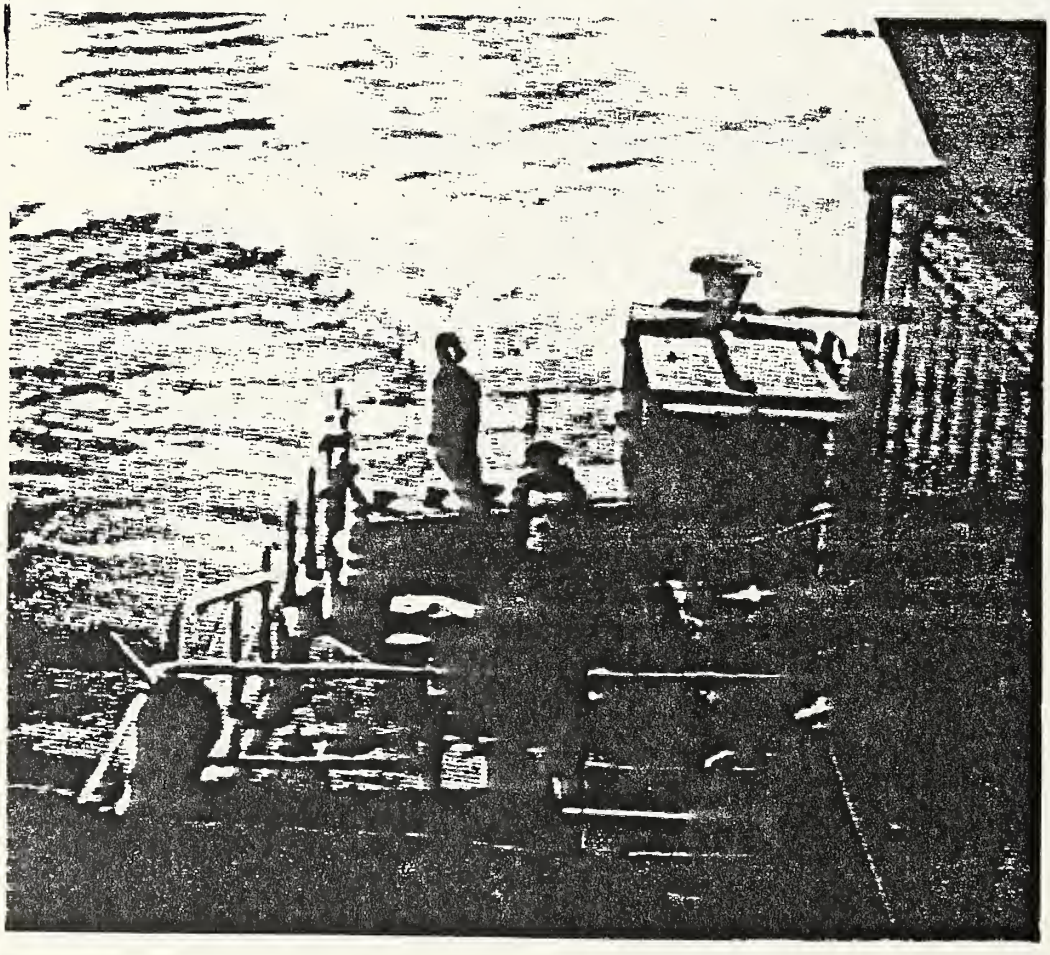
Raytheon has avoided directing European subcontractors to U.S. sources although the U.S. supplied drawings do reference a U.S. supplier, which are often resorted to.[58]

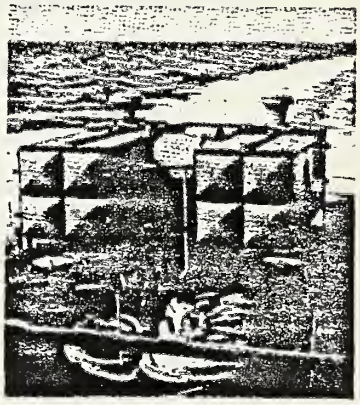
B. Centralized Subcontract Management: The Procurement Agreement and the Lack of an Interceding Layer of U.S. Industry

The fact that three of the European firms developed the equipment they were later to produce, plus all production being single source, have naturally both contributed to a lowering of costs through their favorable impact on requirements for tooling, test equipment, training, and so forth. However, there are two other aspects of the way in which this subcontracting effort was set up that are particularly noteworthy.

A study was made in the initial stages of the production program of the cost problems faced by the European subcontractors in their offering of competitive bids. It was discovered that most cost increases encountered were a result of







Peder Skram Class *HDMS Herluf Tro*
HDMS Herluf Trolle was commissioned April of 1967. As the second frigate of the Peder Skram class, HDMS Herluf is of Danish design and was built by Helsingors J.&M.

the smaller orders and many agents involved, and particularly with largest bulge being in material prices. As such Raytheon decided to pool the effort; at a cost of some $2 million, but with initial savings of some $20 million dollars.[59] This involved:

- Raytheon's offering of "purchasing assistance" to all European bidders, with particular emphasis on SCD[60] pricing;
- a "company wide" agreement and quantity buy prices being made available;
- a large percentage of material being procured in the U.S. by Raytheon and;
- the implementation of a commodity buy technique.

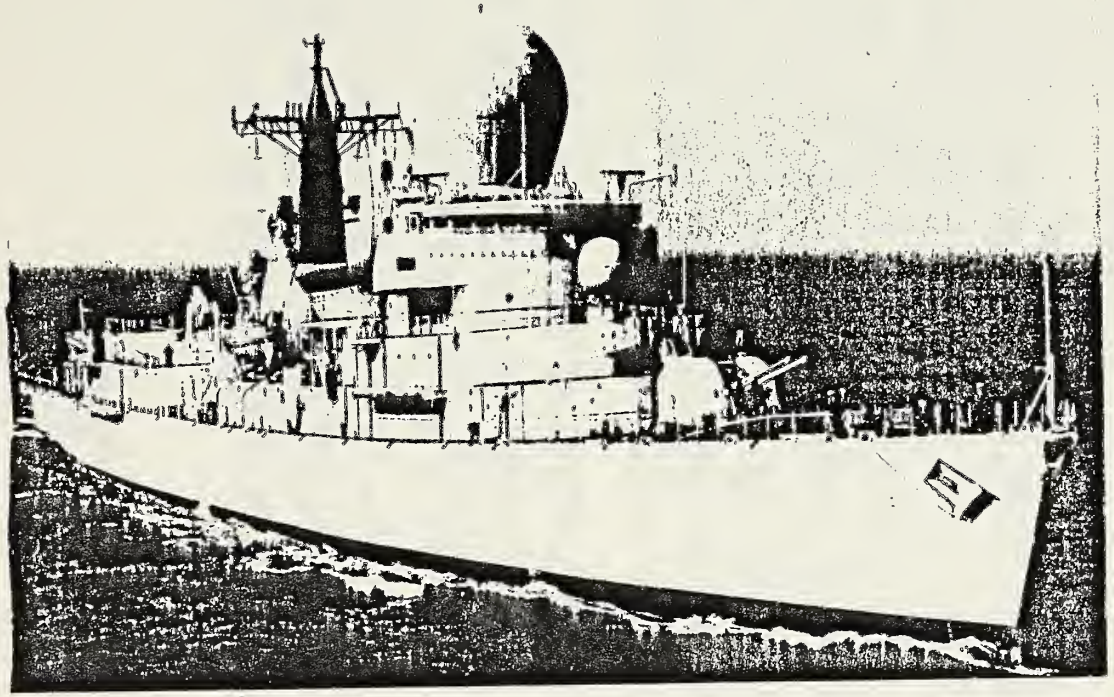
While the above approach contributed to a major reduction in the costs faced by the European subcontractors, another aspect of the structure adopted reduced added costs at the next level up in the effort. Through the centralization of the subcontract management effort allowed by all the European firms being first-tier subcontractors, the NATO Seasparrow program was able to avoid another cost that has impacted other transatlantic efforts (i.e. F-16 and NATO AWACS) wherein a U.S. industry team has subcontracted a share of the work to the industries of European customer governments. This involves the issue of loadings, or mark-ups, placed on second-tier European work packages by the first-tier U.S. subcontractor. Though these mark-ups are totally legitimate within the context of a U.S. led joint program wherein the U.S. Cost Accounting Standards apply, they tend to add a sizeable premium to all second-tier work placed in Europe. These loadings are DCAA approved factors tailored to a given contractors accounting system and business base, being added on to the base price negotiated between the U.S. first-tier subcontractor and the second-tier European one. As pooled

costs applied across a wide range of U.S. government defense contracts and with considerable variance from firm to firm, their suitability, when looked at in isolation for a given transnational project, is somewhat questionable from the view point of the particular grouping of customers. These loadings for other programs have often run in excess of 100% mark-ups where U.S. first tier—European second tier subcontractor teaming is involved.[61] Raytheon, as the only U.S. firm dealing directly with the European subs, however, has been able to apply a minimal mark-up of around 15%, one which covered a modified G & A rate, material handling and profit, and has been much more palatable to the customer(s).

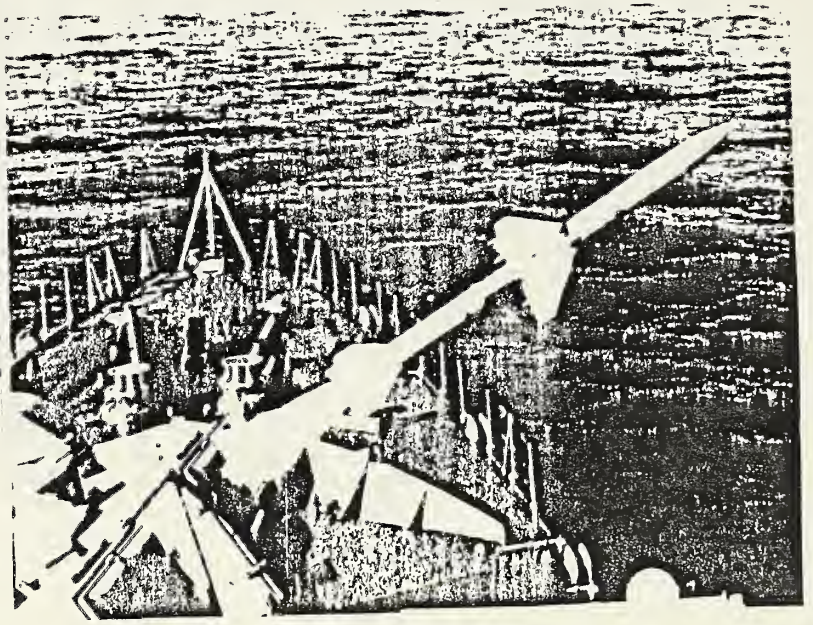
C. RFPs

The above arrangement whereby the Raytheon NSSMS program was able to obtain permission to extend company wide procurement agreements to European suppliers, additionally contributed to the elimination of what would have been the most time consuming impediment in proposal preparation. The fact that the Europeans usually did not have to in turn go to the U.S. vendors, allowed for a very rapid response time.

In the beginning of the program when the Europeans were still a bit leery, there was somewhat of a turn-around time problem, but it never totaled more than three or four months. At this point in time, there was a great deal of management control. Over time, the situation has evolved to one wherein Raytheon is able to obtain verbal commitments over the telephone within 24 hours and fully detailed responses with all data required by DD Form 633



Tromp Class *HNLMS De Ruyter*
HNLMS De Ruyter is the ninth Royal Netherlands Navy ship to carry the name of Holland's 17th century Naval Hero, Michiel de Ruyter. Commissioned in 1976, the De Ruyter is a Tromp class guided missile frigate.



within 30 days. It took 2 1/2 years into the production program before the European subcontractors could be turned-on by a TWX and 5 years before responding to simply a verbal turn-on over the telephone. Being medium and small size firms, they are generally heavily dependent on their banks for working capital, so this RFQ/proposal turn-around time issue was also related to a certain evolution of attitudes on the part of the banks.[62]

Periodically, when a significant problem area that is holding up a proposal has been targeted, Raytheon sends in people to explain, provide additional data, and clear up the concern. Though this is common to any standard subcontract management effort, the need for this tends to occur more frequently in transnational enterprise, as one might expect, especially early on in the program.

Initially the program went through a difficult gestation period prior to production go-ahead in August 1973, with the customer constantly changing specs and initiating delays. At this point, Raytheon was expanding from a base of three European firms participating in development, to eight for production. After six months or so of this, Raytheon was facing European demands for money, if the firms were to continue to participate in the competition. Eventually, a number of the Europeans dropped out, frustrated by the constant revision of RFQs. Though US defense firms were used to operating in this environment, for virtually all of the European firms, this was their first experience as participants in a US government managed development and production program.[63]

Once the production contract was finally awarded in August, 1973, all purchase orders were negotiated within the following 30 day period.

D. Flow-down of ASPR

At the beginning of the engineering development phase the U.S. government recognized the need to waive the flow down of 20-odd ASPR clauses, with the contracting officer having been given a charter to work the waiver of any others that became problematic. This only amounted to a handful of additional clauses, and in general, once adequately explained, the European's were able to live with most of the remainder. The process worked fairly smoothly and once waived for the $4 million dollar segment of the engineering development effort placed in Europe, it was extended to the much larger joint production effort.[64]

Jim O'Brien, the program's subcontract manager cited three representative cases. In one case a European subcontractor hired a major U.S. law firm to deal with questions such as patent clauses over which they were very uncomfortable. This quickly became rather expensive. Finally Raytheon told the firm, "look its not going to be a problem. And we're not going to sit down and spend several days working this issue. We're not going back to the government on this. What you've got is simply a lawyer running around surfacing issues and creating business for himself." The European firm accepted this and decided it could live with the clauses. No problems have occurred since over issue.[65]

In another case involving industrial property rights Raytheon was able to display greater flexibility, since they felt the European concerns were warranted. A European subcontractor protested the right of the U.S. government to drawings for tools and test equipment emanating from its engineering development work, which were not covered directly under the development contract, but were subcontractor provided. Recognizing the concern as legitimate, Raytheon and the contracting

officer agreed that instead of modifying the several boiler plate clauses concerned it would be better to just add a new clause that stated that the customer governments would have no rights to the firm's drawings. This settled the matter.[66]

In yet another case, Selenia, which was destined to become the sole Italian subcontractor, sent over a lawyer who virtually wanted to rewrite ASPR. After several days of dealing with him, Raytheon simply said, "accept them or forget the whole thing." Selenia accepted.[67]

E. Communication/Authority/Visitation

The fundamental rule in the interrelated areas of communication, authority, and visitation, in the words of Mr. Peterson, was simply, "Keep the Face Common." First of all, this contributed to the establishing of close personal ties that allowed for easy bridging of any gaps resulting from the language barrier (i.e. one of the parties having to work through a second language). "Consistency is the key, if they keep with one person, it'll get through." Moreover, both sides must make clear the level at which decisions are made and never circumvent it. "In extremis," Peterson said, "I'll take you to my boss, and you can hear it from him, but I'll be there."[68]

Peterson and O'Brien are the only two Raytheon representatives with contract authority with the possible exception of their sub-contract administrator on site, Wilbur Cartwright. Mr. Peterson flew over to Europe on an average of once per month, spending 40-50% of his time over there, while Mr. O'Brien went over

about 3-4 times a year (e.g. after a number of technical changes have accumulated). Ordinarily, Cartwright, based out of Copenhagen, performs the fact-finding/cost analyst functions, generally laying the ground work prior to negotiations. But if the contract is a minor one (say in the $10,000 to $50,000 range), Cartwright is the negotiator. Otherwise Peterson and O'Brien were the only two subcontract interface points for decision-making/commitments for the program in Raytheon. This has allowed for an almost air-tight subcontract management effort.[69]

The need for this approach was further reinforced by the organization of their European counterparts. Peterson and O'Brien found that the European firms followed a very strict pecking order with regards to commitment authority. Though they put a guy in a position where the outside world would believe he has authority, in fact their negotiators are kept on a very short leash. No written rule is involved, its just practice. Therefore Raytheon Seasparrow buyers work through their counterparts on day-to-day administrative matters, but for decision-making and finalizing negotiations, all commitments are made by Peterson and O'Brien.[70]

Peterson spoke of his surprise early on in the program when one of his buyers and a European counterpart reached an impasse in a particular negotiation wherein the European would not agree to any more than a 1% decrement in the original proposal. After he was forced to intervene, he found in talking to the program manager that a commitment for a 1 or 2% decrement is all the authority the contracts administrator was ever given. Once they became involved, the respective managers were able to rapidly close the gap.

Peterson soon found this to be the rule everywhere. Additionally, they found that even program managers generally only had limited authority, and that it was necessary to go several levels higher in management to a Director, Vice-President or even the President. This in turn required an elevation at Raytheon up to the assistant Program Manager, International Operations[71]. Initially however, it did take some time for Peterson and O'Brien to locate the critical decision maker in each company.[72]

Jim O'Brien cited a typical example of the differing authority structure. As is common practice in updating a proposal due to a slide in the time limit for an original price commitment, the European subcontractor often wouldn't go out again for another round of bidding due to the cost and time involved. Instead they would simply rely on an estimate. It was necessary, however, to first bump the estimate far up (by U.S. standards at least) in the hierarchy for approval.[73]

Inter-related with the above points has been the need to maintain very strict visitation control within Raytheon. The NATO project office assumed the role of providing clearance for visitation. This has allowed for a degree of control over the travel of high level personnel at Raytheon who were outside of the program, to European subcontractors, and thereby minimized the potential for program disturbance through any commitments from this source. In contrast, the F-16 program did not follow this practice and was reportedly having problems in this area.

Early on in the program there were incidents of European subcontractors circumventing Raytheon as prime and going directly to the customer through their national representatives. But after several problems early on in the program, Raytheon was able to make it clear that, "if your having problems come to us, not the customer," (and this, without having to jump all over the subcontractors, as they would have in a purely domestic program). Raytheon was greatly assisted in this task by the NATO Program Manager's knowing to stay out of the inter-industrial relationship side. When European subcontractor complaints came in through national reps on the Steering Committee or at the SPO, that was the end of it.[74]

F. Subcontractor Meeting

Yet another example of the rinkles introduced into a project where transnational enterprise is involved, can be seen in the project's bi-annual subcontractor meeting, or industrial symposium. Following up on a suggestion of Fokker's Vice-President for Contracts and Industrial Marketing, the late Cornelius Ponsen, Raytheon set up in March, 1974 a parallel industrial counterpart to that of the Steering Committee; meeting at the same time and place as the Steering Committee (which were initially every 3 months, but as the program matured, occurred only every 6 months). Raytheon's original position on this matter, however, was simply, "no way." Raytheon intended to continue to be the only industrial member at Steering Committee meetings as it had throughout Engineering Development. Absolutely no subcontractors were to be present. Raytheon feared that its authority would be seriously compromised, vis-a-vis both the customer and the subcontractors themselves.[75]

Raytheon finally did agree, several months after the suggestion had been made, to hold such a symposium, though not without some reluctance. They soon found however, that their fears were totally unjustified. National and firm loyalties and pride, and just plain good sense, inevitably kept the subcontractors from any such temptations.

Raytheon initiates the subcontractor meetings by delivering the report just previously given to the Steering Committee. After this, the meetings review a host of issues covering not only program management, but joint marketing of the NSSMS, as well as development and marketing of the follow-on system, the Seasparrow Lightweight Missile System (SLMS). It is worthy of note that, paralleling Boeing experience with the NATO AWACS projects, Raytheon found it necessary to stop inviting higher management, from Raytheon as well as the European subcontractors. Only then, with program people only present, was a really free and productive exchange and sharing of problems able to develop.[76]

In spite of this evolution towards more of a team approach, when Raytheon is one-on-one with each of its subcontractors at their own plants or in Wayland, the prime-subcontractor relationship basically continues on a normal basis, though occasionally Raytheon does feel the need to reassert its authority.

Consequently, over time, these meetings have played an important role in the inter-industrial relationship becoming somewhat more that of an associate relationship. They have contributed to the evolution of the good working relationship established during engineering development and production, into one which includes not only joint marketing of the NSSMS,but joint design, develop-

ment and marketing of the follow-on Seasparrow Lightweight Missile System. (The SLMS is treated later in this sub-chapter.)

G. Imposition of Management Systems

For the most part Raytheon followed a policy of, at least initially, letting their European subs use their own internal systems. Then, once problems surfaced, the Europeans were very receptive to Raytheon's offered improvements. This was especially prevalent in the area of quality control, where Raytheon systems were usually eventually adopted in their entirety.[77]

The one exception to this involved Selenia, the Italian participant. In the case of Selenia, it would have been a serious problem if they had been allowed to start out using their own systems. Luckily though, Raytheon was a part owner at the time, so imposition of its systems involved little difficulty.

H. Plant Surveillance and Audit

For the NATO Seasparrow project, primary responsibility for site surveillance falls to the national quality assurance and audit authorities. There is a regular delegation of authority for contract administration, audit services, inspection and so forth by the U.S. services, i.e. DCAS and DCAA. For example, during the proposal stage the NSPO in Washington, D.C., instructs the local DCAS in Massachusetts to look at the given work package, and to do what they can with the data available at Raytheon. For the balance of the effort that can't be dealt with state-side, the DCAS office will ask for an assist from the DCAS and DCAA offices in Frankfurt, FRG. If people are available, then the Frankfurt

office will deal with it. However, more often than not it will not have the manpower.[78]

Similar to internal processes within the U.S. government in requesting an assist,[79] the Inspection Branch of DCAS in Frankfurt, to take one example, usually requests support from one of the European national quality assurance services, after first informing the given MOD. The national service will usually provide a resident inspector to assure that good quality practices are being followed (e.g. segregated inspection for incoming hardware, or the proper calibration of tooling). And again, as in the U.S., if no people were available, Raytheon might be asked to fulfill the function, if the subcontractor will so allow.

DCAS or the DCAA does become directly involved periodically if people are available, as in the case of a recent audit for the SLMS launch canister developer involving the Dutch firm Bronswerk. As for the level of audit to which the European subcontractors permitted Raytheon to go (beyond which the DCAA or one of its European counterparts would have to carry the ball), Jim O'Brien reported that there was no discernable difference with that of U.S. subs. Similar to U.S. firms, this was basically a function of the work package, the size and capability of the firm, and how bad they wanted the business. In any event, the facilities and technical evaluations usually tells a prime contractor what it wants to know about a prospective sub.[80] Since the beginning of the production program in 1973, the European books have looked like any U.S. defense contractors books as far as the availability of detailed cost data is concerned. The detail either Raytheon or the DCAA Frankfurt gets

is complete. The program was further assisted several years later by the F-16 program with its imposition of CAS on the common subs.[81]

I. Customs Duties and Tariffs

Although the MOU and the prime contract provided for the waiver of custom duties, implementation was sometimes another matter. For those cases where delivery was critical and a snag occurred, Raytheon adopted the practice of paying duties upon entry of an item into a given country, and reimbursement upon re-export. Pursuing reimbursement by the responsible corporate office was naturally a function of the amounts involved. Problems occurred primarily: (1) early on in the program; (2) when shipments entered nations at other than the established port of entry; and (3) when Europeans occasionally procured certain U.S. vendor items from domestic distributors. Raytheon has never really of money, and the frequency of occurrence has diminished over time.[82]

In the area of customs duties and tariffs Raytheon relied on European subcontractors to each work with their respective governments in implementing the waiver. Over time, customs officials in the ports of entry gradually became familiar with the case, thereby speeding up clearance. In addition, it is worthy of note that this has always been less of a problem in the two smallest participating nations, Norway and Denmark; the problem being in good part a function of size.[83]

Problems arose when shipments did not enter at the designated national port of entry for the program (e.g., Brussels for Belgium, but arriving at Ostende instead), or when the shipment of a part of the pedestal was expedited to Raytheon's Bristol, Tennessee plant, but the flight landed at the Knoxville,

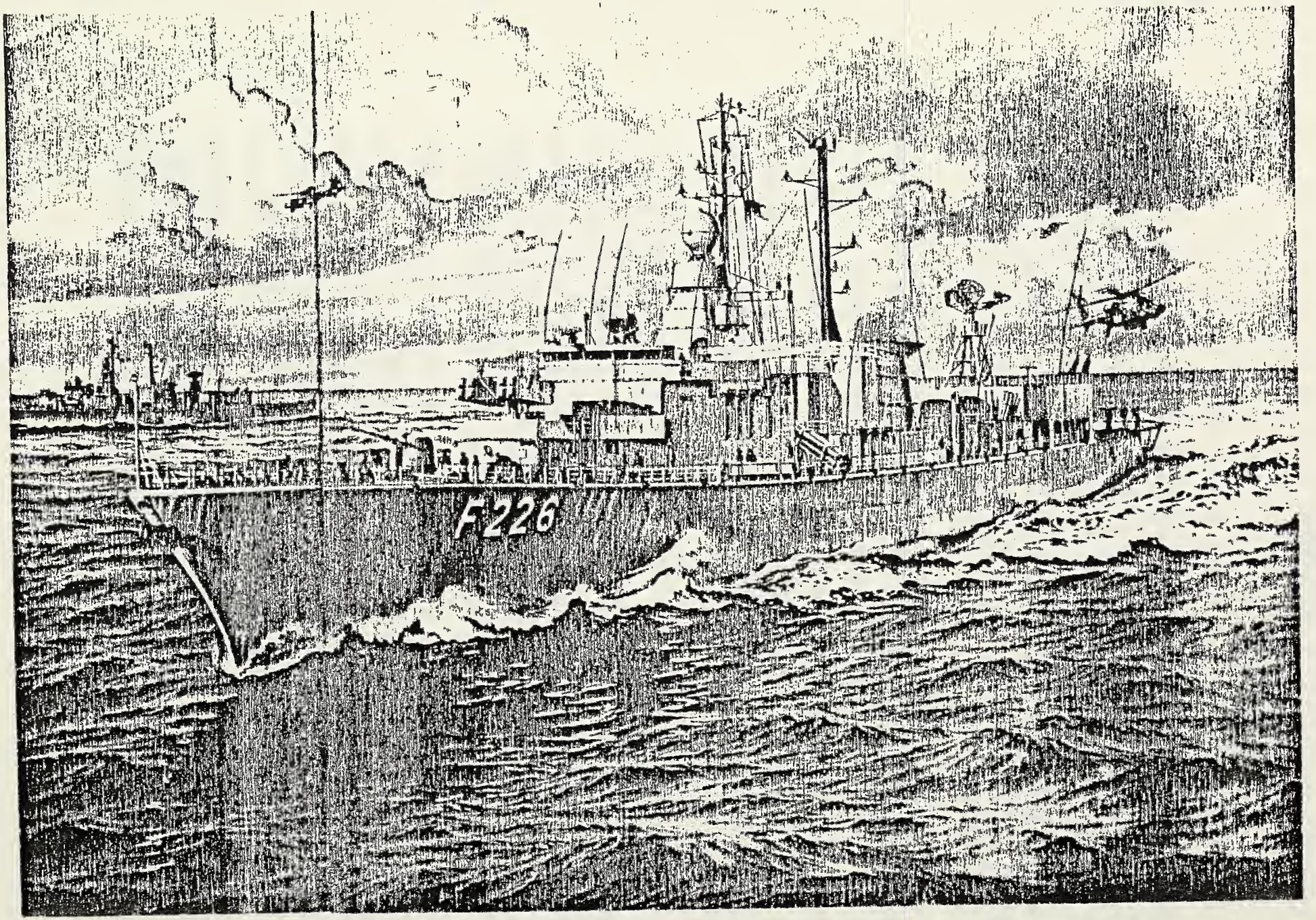
Tennessee, airport instead, due to bad weather (the three U.S. ports of entry are for the program Boston, New York, and Bristol).

The third case would arise when MBLE, to take one example, would buy a number of Motorola semi-conductors from a Belgian distributor for around $50 each for reasons of timeliness, instead of resorting to the more time consuming process of ordering the parts through the normal channels from the U.S. for $35 each.[84] In such a case part of the price difference could be accounted for by the Belgian distributor's having already paid the tariff upon import into Belgium.[85]

J. Miscellaneous Financial Issues

The NSSMS foreign currency payment system is a relatively simple, yet successful one. As is common policy, the project had a mechanism for insulating the contractor and its subs from gains or losses due to currency fluctuations. The governments collectively assumed all risk in this regard, indemnifying the contractor against any movement between the fixed contract payment rate and the variable actual (i.e. market) rate, periodically settling accounts. Raytheon is responsible for: 1) paying its European subcontractors in their own currencies, and 2) the tracking currency fluctuation effects for the second tier subcontracts.[86]

European payments to the U.S. government, as well as all payments to Raytheon, are in dollars. Raytheon, in turn, paid the European subs in local currencies at market rates. The cost or gain due to any change in the original exchange rate is shared by the participating governments, through their agent, the U.S. Navy, there being no net effect on Raytheon or the other contractors.



Federal German Navy *Frigate Type 122*
Construction of the Type 122 frigate is due to start this summer at the Bremer Vulkan shipyard. The German Navy construction program provides for the building of six Type 122s between 1981 and 1984

A quarterly price adjustment to the prime contract is made to cover the currency fluctuations. The contract price is based upon May 1, 1973 exchange rates. Any price adjustments made because of currency fluctuations experienced at the first and second tier subcontractor level may change the target cost and ceiling price, but not the profit provided for in the Raytheon contract. Raytheon actually procures the proper foreign currency as it is needed to make subcontractor progress and final payments. Raytheon maintains a separate corporate office to take care of currency requirements for all of its foreign contracts. Purchases of currency are made based upon subcontractor performance or delivery dates. Raytheon, as well as the subcontractors, maintain complete records on all transactions on the subcontract, including dollar payment and exchange rate obtained, date paid, and the difference from the fixed rate.[87] The quarterly adjustment is subject to audit by DCAA.[88]

One lesson learned from the NSSMS experience in the area of foreign exchange cited by Mr. Peterson, is that it would have been better to have pegged the original contract exchange rate to an historical average than the rate on an arbitrarily designated date. For the NSSMS project the former approach would have involved less of a swing between the periodic settling of accounts.[89]

In another area, any changes to Raytheon drawings that effects its European subs, or requirements for other out of scope services that would generate an SCP, are charged to Raytheon at agreed to rates. The previous practice for most European subcontractors had been to treat such changes as indirect charges covered in overhead, but when the NSSMS project came along, with the uncertainty and design

fluidity inherent in defense contracting (the first significant defense program for several of them), they decided to follow the safer route of direct charge.[90]

As in other later transatlantic programs, the European subs protested the standard U.S. practice of making only 80% progress payments against actuals, and the strain on working capital this entailed. They did accept it however, and have learned to live with it, for this program at least.

A related issue, provides us with an example of the informal mechanisms this program was able to resort to because of its lower visibility. Since one of the European governments had to not only obligate their money by the end of the year, but spend it, something had to be done with excess funds prior to their being accepted by the U.S. Treasury. The program operated, however, outside of the FMS system. Consequently, it was decided that an interest bearing pass book account would be set up in the name of the NSPO program manager where such funds could be provisionally deposited.[91]

K. Scheduled Delivery of Hardware

Raytheon is now finding that it is much easier to get overtime work and work on holidays and vacations, than ten years ago. Nowadays, if there's a real problem Raytheon can get a small force in to break the log-jam. This has been a recent evolution over the last several years. Previously it was simply out of the question. There would be difficulty, however, if Raytheon ever tried to obtain overtime work to the extent it is resorted to in the U.S. Moreover, obtaining concurrence from the Europeans for extra work is possible only when they're behind schedule; for acceleration it is still not possible.[92] Italy

was the only exception to this evolution, in that overtime is still out of the question under all circumstances. With the engineering development program having been a joint effort, by the time the production program came along in 1973, Raytheon had already been disabused with regards to the European socio-labor environment (e.g. a shorter work year, and only 1-shift at most plants). There was to be one rude surprise however in the area. That involved the extent to which overtime earnings are discouraged; overtime earnings being taxed at a rate higher than for standard hours.[93]

Since the NATO Seasparrow program is now a mature one, the No. 1 schedule problem for their European subs results from US vendors no longer producing certain Raytheon Furnished items (CFP). Responsibility for working this problem, however, falls to Raytheon who tracks down alternate sources and expedites delivery.[94]

L. Technology Transfer

Following is a sort of checklist, along with Mr. Peterson's responses, covering some of the standard problem that arise during technology transfer programs, be it to subcontractors or licensees.

(a) During the transfer of technology how successful was Raytheon in avoiding inundating its subcontractors with unnecessary engineering data, while also avoiding gaps in the data sent (drawings, documentation, whatever). Any particular cases?

- Gaps were the problems, not excess. We assumed that they had all the referenced specs, procedures, etc. We later had to supply each with a full set of Mil specs, standards, and so forth.

(b) The extent to which original estimates were on target as to the amount and type of training required at the European subcontractors, and Raytheon's success in strengthening its capabilities in certain areas to offset any corresponding weaknesses of the European subs?

- Since the manloading (particularly Raytheon) was properly budgeted, it was on target.

(c) Was it adequately established early on how the European subcontractors could best receive the data?

- Yes.

(d) Was Raytheon able to staff resident teams and get them in place early enough?

- Yes.

(e) Did coordination/communication between resident teams and program management at Wayland go smoothly? For example, how successful have you been in dealing with the natural tendency of resident teams to operate as a separate entity, or functionals to communicate in a vacuum, divorced from program management?

- My ocean hopping helped keep islands from being formed.

(f) Were there any facility approval problems (e.g. initial approval followed by required changes)?

- Yes, but no big deal.

(g) Any other technology transfer issues of note?

- Aluminum welding was an area totally unknown in Europe at the outset. We had to train all the subcontractors.[95]

M. Thomas Peterson's prioritization of factors contributing to the success of the transnational subcontractor management effort.

In response to the author's query as to, "What would you say was the single most important factor contributing to the well set up and managed NSSMS subcontract management effort? How would you prioritize the remaining factors?" Mr. Peterson responded as follows:

1. Contributions of key actors,
2. All European subcontractors were first tier,
3. A good technology fit for the European industries involved,
4. Raytheon was their customer and not their Navy, and their navies made that fact known,

5. Enough time for proper planning, since the Development Phase (International) preceeded prosecution,
6. Less visibility enjoyed by a medium size program.[96]

5. Logistics Support

As seems to be the norm, even for jointly developed systems, the possibility of using any of the NATO Maintenance and Supply Agency's (NAMSA) range of services for follow-on support of the NSSMS was never seriously considered (at least up until recently). As pointed out in Chapter 4, even if considered at an early enough stage, where one nation has a dominant position with regards to the development and production effort, it is often simply more cost effective (though not necessarily so) for the other procuring nations to plug into that one nation's logistics system on a bilateral basis.

Such was the case with NSSMS,[97] except that there was also a multilateral MOU signed that granted blanket approval for third country transfers within the NATO Seasparrow community for spare parts.[98] Spares are procured for all customer Navies by the USN's Ship Parts Control Center (SPCC), Mechanicsburg, PA. The SPCC goes out directly for bids to the firms of all participating industries.

The Seasparrow's principal logistics support problem was related to getting the SPCC, to the point where it would start up support capability. The SPCC insists upon a 95% rate for items where the design has been fully stabilized, before it will start up support for a system. For some 2-½ years the system hovered between 88% and 91% and Raytheon unexpectedly found itself having to do its best to provide the support itself to the several navies in the interim.
As of mid-1981 the Europeans were once again discussing the setting up of a European depot for the maintenance, overhaul, and repair of the NSSMS. The Netherlands has been the principal nation pushing the concept and Den Helder, in

the Netherlands appeared to be the top choice. It's hard to say whether they will finally follow through. In addition, NAMSA has entered the picture, offering its services to the interested nations. Whichever approach is adopted, each nation will have the option of tapping the U.S. or the European depot for individual services. Such a depot would also offer the possibility of German and Greek industry assuming a role in the program.

Interrelated with these developments, the NSSMS is also involved in the on-going effort to implement the logistic support part of the NATO Long-Term Defense Plan (LTDP) drawn up in 1977. Forward area ordnance support bases are to be established for the U.S. Atlantic fleet since there is currently no in-theater capability/facility in the eastern Atlantic area for accomplishing minor maintenance, exchange of components, or conducting ready for issue tests of modern sophisticated weapons. During a prolonged period of advanced readiness or hostiities many of the USN's missiles and torpedoes would have to be shipped back to the U.S. for relatively minor repairs. Bi-lateral arrangements have been made with the UK, the Netherlands and Iceland; while SACLANT has submitted projects within the framework of the NATO Infrastructure Program[99], to provide or improve support facilities. These projects include maintenance facilities for the NATO Seasparrow and Harpoon missiles, an advanced underwater weapons laboratory, and a torpedo workshop and missile checkout facility.[100]

6. Sequel to the NSSMS - the ASPIDE, RAM, AND RIM-7M Missiles

There have recently been three other ordnance related developments involving the NSSMS that serve to portray an image of an ever more complex network of inter-allied projects:

(1) The Italian Aspide missile is being unilaterally developed as a replacement for the RIM-7H missile, for use with the NSSMS FCS and launcher;

(2) The Rolling Airframe Missile (RAM), involves unilateral development on the industrial side in the U.S. by General Dynamics' Pomona Division under contract to the Naval Sea Systems Command. It is being jointly funded by the U.S., the FRG and Denmark under an MOU signed by the three governments, to be followed by multinational production. The RAM can be fired from either an NSSMS launcher or a stand-alone launcher.

(3) The RIM-7H is being replaced by the RIM-7M for the U.S. Navy.

A. Aspide

The Aspide missile has been developed by the former Italian member of the NSSMS team, Selenia, to eventually replace RIM-7H for the Italian Navy. The Aspide has a Sparrow body and is mechanically directly compatible with the NSSMS launcher, from which it was successfully fired by one of the Italian Navy's LUPO class frigates in July, 1979. Four frigates of this class in the

Italian Navy currently equipped with the NSSMS system are scheduled to replace their RIM-7H missiles with the Aspide.

Spain is also currently acquiring the NSSMS to be used in conjunction with the Aspide missile.

B. RAM

The Rolling Airframe Missile (RAM), designated XRIM-116A, was, designed to meet the requirements of the U.S., the German and Danish navies for point defense in a high threat environment. The system can be traced back to the U.S.N.'s Dual-Mode REDEYE (DMRE) missile program. The DMRE feasibility and demonstration program was initiated in June, 1972. The DMRE program involved a joint effort of the Applied Physics Laboratory of John Hopkins University (APL/JHU) and General Dynamics' Pomona (GD/P) Division under contract to the Naval Sea Systems Command. The FRG joined the advanced development program in July, 1976, agreeing to pay, with a contribution of $7.4 million, about ½ of advanced development costs. GD/P was selected as prime contractor, with APL/JHU designated as technical support agent. The cost-plus-fixed-fee contract was executed with GD/P in February, 1977. In June 1979, following ratification of an MOU by the U.S., the FRG, and Denmark covering joint funding of development to a common requirement under the guidance of a NATO Steering Committee, GD/P was awarded a $94.8 million contract by the Naval Sea Systems Command for full-scale engineering development of the RAM.

RAM is among a group of weapons intended to engage targets which have either survived area defense weapons, or those which suddenly pop up at close ranges such as those fired from submarines.

RAM missile is intended to bolster ship defense systems by adding firepower in defense against antiship missile attacks which could be launched from surface vessels, aircraft or submerged submarines. Modes of attack could range from high-diving to surface-skimming missiles, but initial (Block 1) Ram missile development will focus primarily on the low-level attack, which is considered the prime threat because of the short advance warning it provides.[101]

On larger ships, the system would be aimed primarily at stopping missiles that have slipped through combat air patrol and long- and medium-range missile defense systems, or those that have been launched close-in by submarines to avoid area defenses. The missile also could be used as a primary weapon system on small vessels.[102]

RAM will be able to be fired either from existing NATO Seasparrow launchers, or from a low cost lightweight stand-alone launcher being developed by GD/P. RAM does not require a separately developed FCS.

The stand-alone launcher is a Model 0 system, utilizing a 24-cell launch unit which would have about 90% commonality with the Phalanx automatic gun system. The Phalanx system is also produced by General Dynamics for the U.S. Navy.[103]

RAM alteration of the Navy eight-cell NATO Seasparrow launcher would include the same control components, but would launch RAM missiles from two inboard cells of
the launcher. Five Ram missiles would be loaded in each of the two inboard cells in addition to single Seasparrow missiles in each of the other launcher cells.[104]

The typical number of launchers envisioned for operational use would be two for ships the size of a German frigate, and perhaps four — one at each corner — for a ship the size of a U.S. aircraft carrier.[105]

The missile is based on the Navy's AIM-9L Sidewinder air-to-air missile, but has a rolling airframe to reduce control section costs, and dual-mode guidance to increase operational flexibility in poor weather conditions.

RAM motor and ordnance package are similar to the AIM-9L, but the RAM has a new autopilot, radio-frequency guidance receiver, two radio-frequency antennas, two rectangular fixed wings and two control surfaces in its control package.[106]

Passive guidance systems will enable the system to react quickly to multiple targets during a missile barrage.[107]

The rolling airframe concept was applied to the RAM missile to minimize system cost and weight and increase operational reliability, officials said. The concept, which has previously been used in the 2.75-in.-dia. Army/General Dynamics Redeye and the Army/General Dynamics Stinger missiles, requires two

instead of four control surfaces and half the usual control electronics. The rolling motion is induced by four small guide rails in the missile's launch canister.[108]

To date, Belguim is the only other member of the NATO Seasparrow consortium to express serious interest in RAM, and it may join the NATO Project Steering Committee as an observer.

This development project will last approximately four years, and will be followed by a production decision. The anticipated initial delivery date is 1984. The RAM is expected to deal with the threat through the mid-1990's. Navy sources have indicated that the total value of the program would be in the neighborhood of $1 billion of which between $600 and $700 million would be for production.

Unlike the NATO Seasparrow program, the RAM development program is a purely U.S. industry effort. However, German, and possibly other European industry, is expected to come into the picture during production. GD/P has been discussing various production arrangements concerning the stand-alone launcher with a German consortium including Dornier, VFW, MBB, and AEG-Telefunken, to offset the FRG's order.

The FRG will procure the RAM with a stand-alone launcher, while the other nations are expected to use the eight-cell NSSMS launcher—two of which will be fitted for RAM.

Raytheon will perform the RAM NSSMS launcher insert for the U.S., Denmark, and any other procuring nations with the NSSMS launcher. Raytheon will possibly have to provide offsetting work of equivalent value (circa $100,000 per launcher) to the national orders - either internally or externally.

C. RIM-7M

The USN selected the RIM-7M to replace the RIM-7H in its upgraded NATO Seasparrow systems for the 1980's. As a purely U.S. effort, the AIM-7M/RIM-7M has been under full scale development by Raytheon following a competitive fly-off between Raytheon and General Dynamics in 1978. Raytheon is producing both the guidance system and warhead, with General Dynamics acting as second source.

The RIM-7M, with its mono-pulse seeker, has greatly improved look-down capabilities through clutter against sea-skimming anti-ship missiles and is almost impervious to counter-measures. The RIM-7M will increase the range of the NSSMS by around 50%[109]. Testing of the AIM-7M has been very successful.

The main change in the NSSMS system that adaptation to the RIM-7M will entail is a change in the launcher rail.

7. Product Development: The Seasparrow Lightweight Missile System (SLMS) and Landsparrow[110]

A fourth related follow-on development is the Seasparrow Lightweight Missile System (SLMS), a system that has recently evolved from the NSSMS along lines of import for future joint US-European development projects. Raytheon signed an inter-firm MOU in June, 1977, with most of its previous European NSSMS industrial partners (i.e., no government participants) to develop and produce the SLMS. In addition to Raytheon, this includes a grouping of Belgian, Danish, Dutch and Norwegian firms.[111]

A minor modification of the Seasparrow system has also led to the offering of an air base defense variant of the system, the Landsparrow.

A. The System

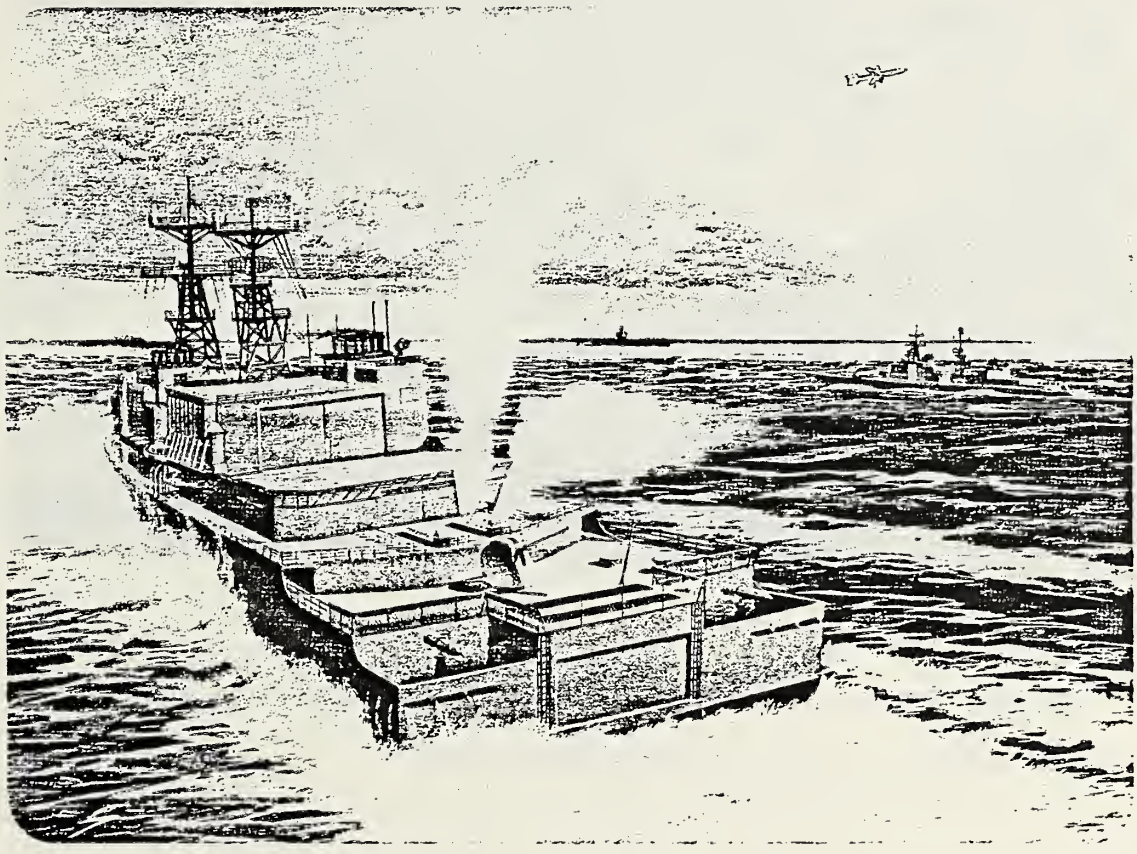
SLMS builds upon the technological advances which have occurred since the development of NSSMS, to achieve dramatic improvements and significant cost reductions. SLMS furthermore takes advantage of the evolution of the Sparrow missile family, from the presently used RIM-7H to the RIM-7M.

As part of the multinational effort, Raytheon is adapting the RIM-7M missile for vertical launch by the SLMS.

The Raytheon led consortium has taken advantage of advances in technology to incorporate into the SLMS improvements in performance, reliability, and ECCM capability, while dramatically reducing weight (by 29%), deck area (by 42%), and

Seasparrow Lightweight Missile System

SLMS



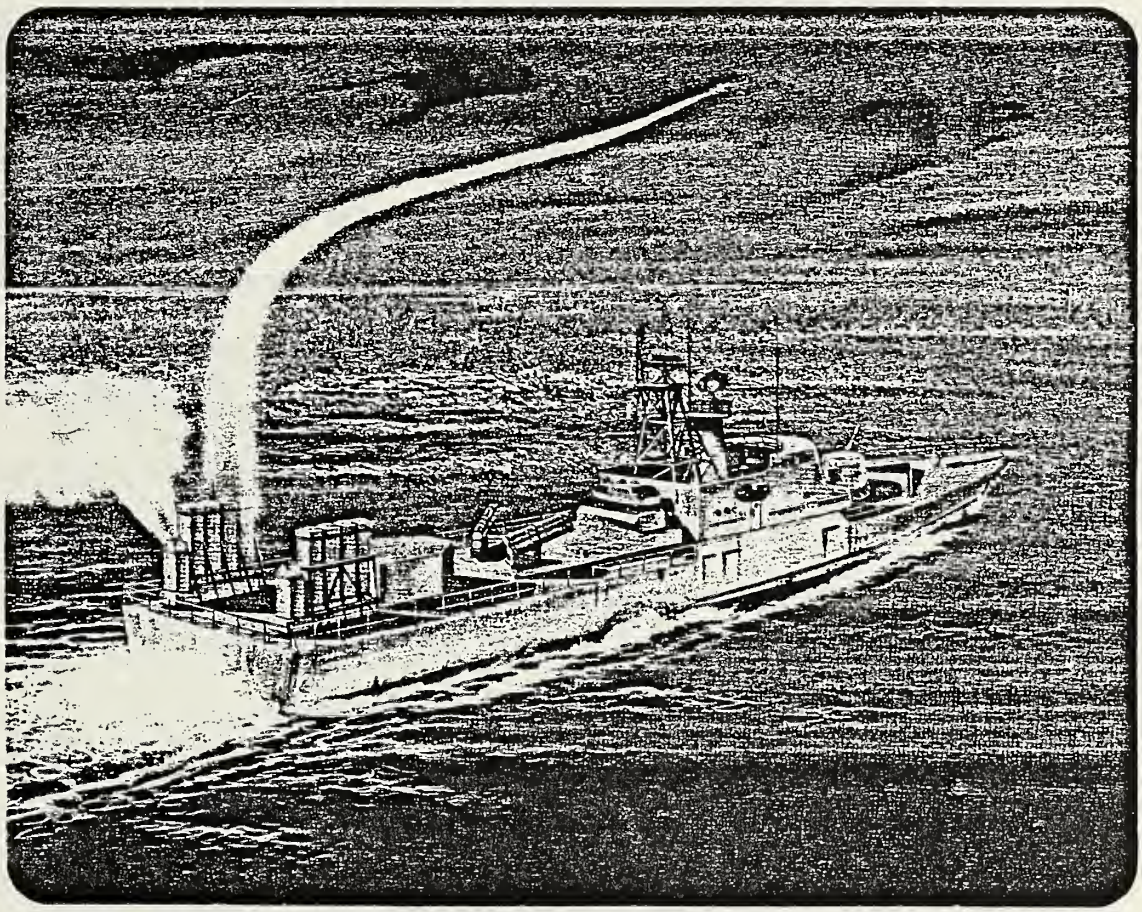
power requirements over those of the the NSSMS. These reductions in weight, size and power requirements make the system suitable for smaller ships (150 tons and up).

As a system incorporating the vertical launch concept, SLMS offers several other advantages. With vertical launch systems (VLS) the cannister functions both as a shipping container and launch tube. This allows for a greater number of missiles on ships and a faster launch sequence than is possible in the conventional rail-launch arrangement. The systems also help reduce reliability and maintainability problems because the missiles are sealed in cannisters at shore-based loading stations. Moreover, a VLS permits greater flexibility in locating the launchers. No matter where it is placed on the ship, it provides a 360 degree free fire zone.

B. The Team

The costs of SLMS development is figured at around $15 million. Raytheon is funding $10 million and six of its seven European industrial partners, collectively, the remaining $5 million. Besides Raytheon, the consortium includes MBLE (Belgium); Nea-Lindberg and Dansk Industri Syndicat A/S (Denmark); Fokker BV and Bronswerk-Amersfoort (Netherlands); and Kongsberg Vapenfabrikk (Norway). About $10 million is for research and $5 million is going into Seasparrow subsystem development divided roughly as follows:

- the development of the AIM/RIM-7M missile is outside of the multinational SLMS project, being a USN-Raytheon project;

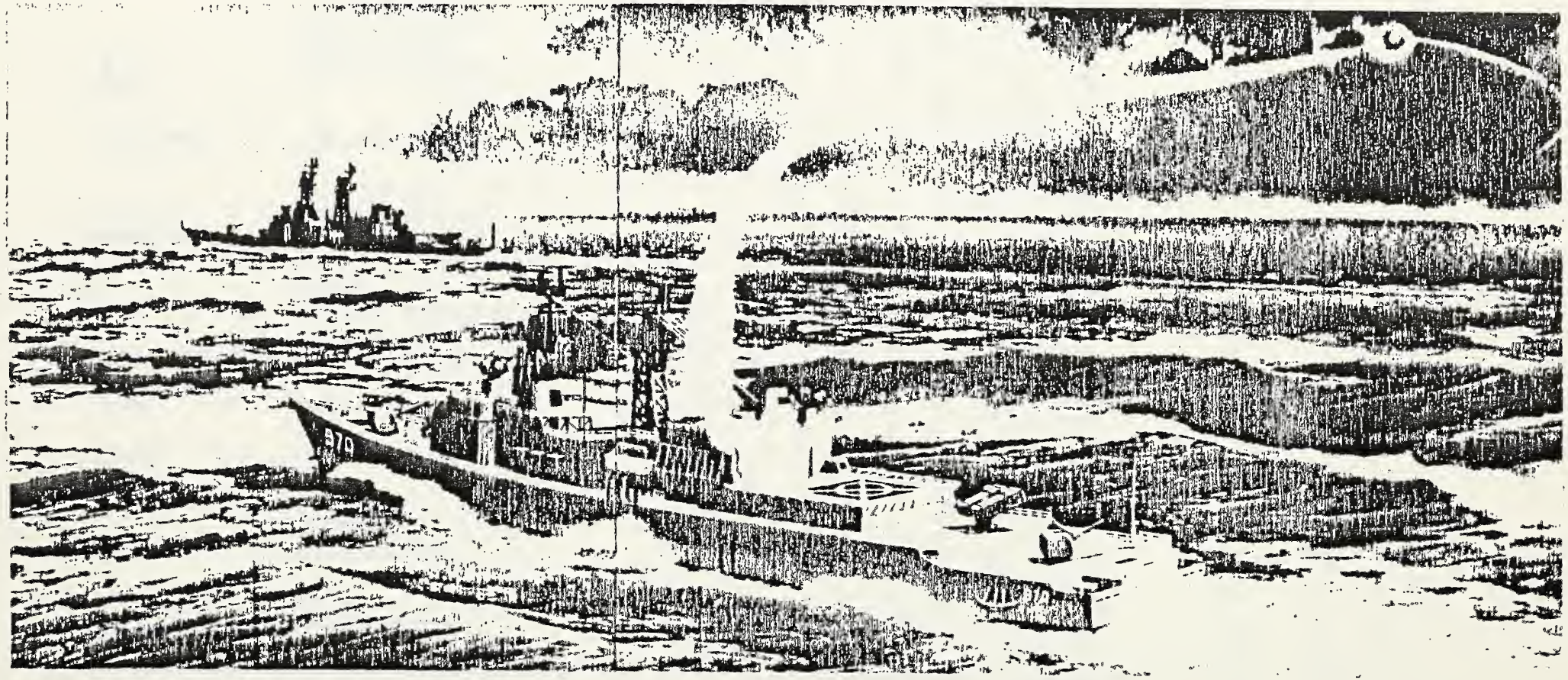


while the multinational SLMS development effort is divided so that:

- Raytheon is developing the jet vane control (JVC) and most of the fire control system (FCS), and;
- the participating European firms are developing the balance of the FCS, and all of the vertical launch system.

A conspicuous difference between the NSSMS industrial consortium and its follow-on SLMS consortium is that the sole Italian participant, Selenia, is missing. Selenia was simply not interested in participating. As of the fall of 1979 there had also been some interest from industry in both the FRG and Canada vis-a-vis some sort of participation in SLMS. However, since neither of the industries were involved in the original NSSMS team - except for Raytheon Canada's manufacture of certain elements - corporate ties are not as well established. All of the remaining participants of the NSSMS industrial team are also risk sharing participants in SLMS, except that one of the three Danish participants, Terma, is only contributing an existing system.

Participating Company	Equipment	Design		Component Systems		
		new	existing	Fire Control System	Vertical Launch System	Missile
Belgium						
MBLE	Missile Launch Control	X			*	
	ASP processor PC Boards	X	X	*		
Denmark						
Terma	radar receiver		X	*		
DISA	exhaust control	X			*	
NEA-Lindberg	high voltage power supplies ship	X		*		
	mounting interface (elect)	X			*	
Netherlands						
Fokker	director control		X	*		
	unit erector	X			*	
Bronswerk	launch cannisters	X				
Norway						
K.V.	director pedestal		X	*	*	
	ship mounting interface (mech)	X		*		
U.S.	jet vane control	X				*
Raytheon	antennas		X	*		
	control monitor		MOD	*		
	amplifier oscillator		MOD	*		
	system control console		MOD	*		
	software		MOD	*		
	ASP processor	X		*		
Raytheon	AIM/RIM-7M missile	X				*



Since fitting the SLMS and RIM-7M missile does not in itself provide for a full anti-missile capability, Raytheon began company-funded development of a 2-D radar in 1976. The radar was successfully demonstrated for the first time in September, 1977, aboard the Norwegian destroyer KNM Narvik during a NATO exercise. While continuing with this radar, Raytheon is developing a more sophisticated Multi-Beam Acquisition Radar, (M-BAR) to provide 3-D capability (elevation as well as bearing, range, and range rate).

Discussions have been in process with German industry for participation on the M-BAR radar, but with no success to date.

Raytheon has already made presentations on SLMS with M-BAR to the U.S. Navy, the Royal Danish Navy, and the Royal Netherlands Navy. A presentation was also made in Brussels in September, 1979, at the NATO Naval Armaments Group's (NNAG) Information Exchange Group No. 1 (IEG/1) on Above-Surface Warfare.[112]

C. Project Management and Financing[113]

Raytheon serves as SLMS project manager during the current IR&D phase and will assume the role of prime contractor if, and when, a development and/or production contract is ever received for the system. In the interim each signatory company agreed to bear the full cost of development for its assigned tasks, as well as its marketing effort, and therefore each accepted the responsibility for the risk of loss of its investment.

As project manager Raytheon is to:

- manage the project through both development and production phases, with the advice and counsel of the participating companies (PC's);
- exclusively devise and prescribe statements of work and establish performance specifications for the PC's for each of their allotted development tasks, and;
- for a period of at least five years following initiation of the production phase, assume the sole direction of the marketing of SLMS. Each of the PC's will however, use its best effort to assist the project manager in marketing activities with their respective countries. All liaison with any customer government before and after any contract award is to be by, or at least through, and with the approval of, the project manager.

Upon receipt of an eventual contract by Raytheon, the system will be co-produced by Raytheon and the PC's, which will be operating under subcontract to Raytheon. Each firm will produce that part of the system for which it incurred the development expense, regardless of national orders. Being a purely industrial venture, production allocation is not a function of whether, or to what extent, a given national industry's government orders the system - i.e., the concept of 'juste retour' is irrelevant for this project.

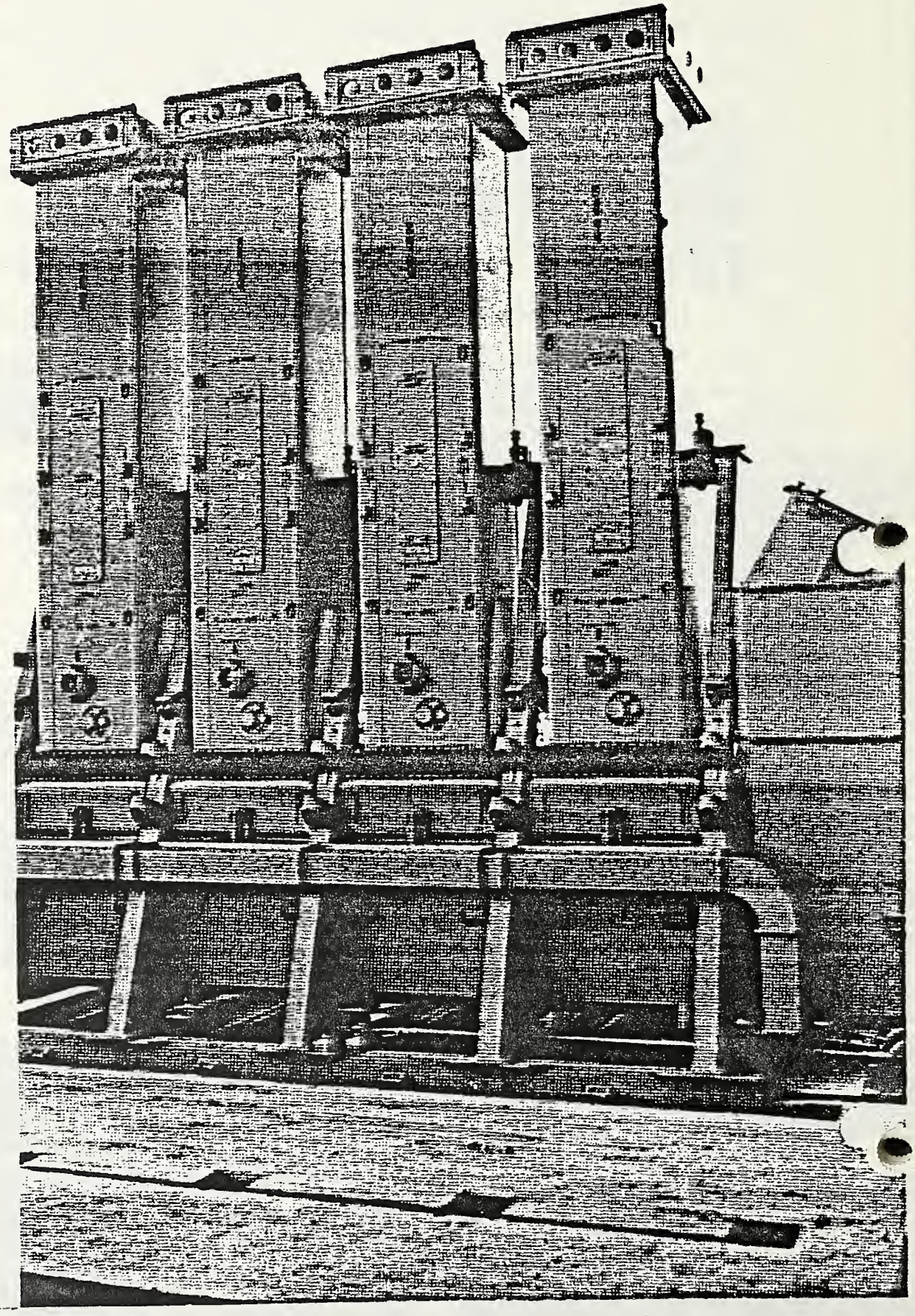
Any redistribution of work within the consortium will involve the granting of a use, make, and sell license by the developing firm which will be compensated by a 'reasonable royalty.' Situations dealt with specifically in the MOU, that would lead to such a diversion of work are:

- if the customer government's regulations prohibits procurement from the PC;

SEASPARROW VERTICAL LAUNCH SYSTEM



SEASPARROW VERTICAL LAUNCH SYSTEM



lore ready missiles...up to 16 issiles per launcher system... o bli- ' zones...hemispheric over

oes not require centerline ck space...can be installed deck, in deck, or bulkhead ounted.

o moving parts...no power rives, braking devices, or rvos.

- if the customer government refuses to approve procurement from the PC;
- if the project manager determines that the project is being jeopardized, or;
- if any of the PC's decides to discontinue its participation.

This uncluttered business arrangement is the ultimate in simplicity, and in the case of this project will probably prove to be acceptable to future customers. This formula is also applicable to a wide variety of projects of similar scale. However, the acceptability of such an arrangement to national industries and governments, once they move past a certain threshold in the resources required, can be questioned. When a venture requires assumption of risk/investment at a level that is unacceptable to private capital, governments are bound to enter the picture along with the concommittant political considerations.

D. The Joint Test Program

The development and testing of the component systems of the SLMS have moved forward separately. Being built up from the NSSMS, permits modular expansion to a SLMS. The vertical launch system (VLS) is being pushed first, since it is simpler to install on the existing NATO Seasparrow systems. The lightweight fire control system will be introduced later. As previously stated, the AIM/RIM-7M is under going its own separate USAF/USN test program.

The first launch test of the VLS system was in September 1980, at USN's China Lake test facility in California. The test was successful with the exception of some minor exhaust problems. On November 18, some two months later, came the first guided launch test, again at China Lake. This test was also a successful one.

The next stage in the testing of the VLS took place in February, 1981, in Puerto Rico, at the Roosevelt Roads, Atlantic Fleet Weapons Range. The sea demonstration at Roosevelt Roads was jointly sponsored by three NATO navies, those of Canada, the Netherlands and the U.S. The USN provided the firing range and a number of early model RIM-7M missiles. The Dutch government contributed about ½ million guilders[114] and Canada contributed the launch platform, the destroyer escort HMCS Huron, which was outfitted in Halifax prior to sailing to Puerto Rico. The Raytheon led-team for its part, provided the system, the people and know-how.

The sea demonstrations of the VLS were completed with two successful firings out of two.

Each vertically launched Sparrow missile was equipped with the Raytheon-developed Jet Vane Control (JVC) and as each lifted off, the JVC maneuvered it so that the seeker could acquire the target drone, which was being tracked and illuminated by the ship's fire control radar. Acquisition by the seeker was accomplished in the prescribed time. Guidance was automatically transferred from the JVC to the missile's autopilot, the JVC was cleanly jettisoned, and the missile proceeded to target intercept.[115]

E. Canadian Interest in SLMS

The Canadian government's participation in the Roosevelt Roads demonstration stemmed from its interest in the SLMS for two up-coming programs: the refurbishing of the Huron class of destroyer escorts and, the new six-ship Patrol Frigate Program. Both programs are expected to go-forward sometime during 1982-

1983 time-frame. The go-ahead on both programs has slipped repeatedly over the last several years.

The refurbishing of the Huron class DE's involves the replacement of older pre-Seasparrow systems.

The Frigate Program is a major new re-equipment effort almost the size of the CF-18 New Fighter Aircraft program. For awhile it was an either-or choice between the two, but this is no longer the case. The industrial participation portion of the Canadian Frigate will be less structured than that of the New Fighter Aircraft program (see Chapter 11).

F. Landsparrow

As opposed to the major step-by-step up-grading of the NSSMS represented by the SLMS a minor modification of the NATO Seasparrow system has led to a Landsparrow configuration. Whereas the French Crotale evolved from a land to a sea based surface-to-air system, the Sparrow family has evolved from an aircraft launched anti-aircraft system to a ship-based point-defense SAM system, and now finally to land-based point-defense SAM system. The latter step in this evolution has involved only minor modifications, in comparison to the first step.

Since a CVN is basically just a floating air base the same concept naturally applies for land based airfields. The NSSMS team is not really introducing a new system. In fact two participating nations, Denmark and Norway already have land-based sites in their inventories for training purposes. What changes are required for adjustment from a ship to a land-based mode are actually, for the

most part, derived from a lessening of the constraints under which the system must operate. For example, instead of a liquid-cooler operating on sea-water, for Landsparrow a standard air conditioning system will do. In addition, exhaust fumes are no longer a problem. Another major difference, but one that does involve an up-grading of the basic NSSMS is that the ship-based systems can rely on a ships own larger targeting system for passing on data. For the stand-alone ground base system this required the addition of a radar to the standard director system.

For base-defense, the Landsparrow fills a gap between the Roland and the Improved Hawk SAM systems. In range Landsparrow falls roughly half way between the two. A case can be made that base defense calls for a system in this range, since it is not a smaller mobile system for field operations as the Roland, or an area defense system as with the Improved Hawk and Nike networks (and their collective successor, the Patriot).

If one looks at the mission, with regard to the four northern European participants of the NSSMS program in particular (and the only European customers whose industries are still participating) the largest single defense related expense in the late 70's and early 80's has been the re-equipping of their Air Forces with the F-16 fighter. As such there is some logic to making air-base defense the no. 2 priority. Norway has been particularly interested in filling this requirement, though it had already signed an MOU with the U.S. government for the purchase of the U.S. Roland. Norwegian interest in the Landsparrow as an alternative to Roland has been closely inter-related with

the ups and downs of the funding battle at the center of which the U.S. Roland program has found itself.

The principal sales prospect to date for the Landsparrow system has come from the other end of Europe, the Greek Air Force. The Greeks had a requirement for 12 such systems to provide air defense for 4 air bases. Those systems competing for the contract were, in addition to the Landsparrow (Sparrow Air Base Defense System) were Roland (Euromissile), Rapier, Crotale, and Skyguard/Sparrow.

When the Raytheon led team bid the Greek contract in the Spring of 1979, they offered a Landsparrow, or Sparrow Air Base Defense System, based on the NSSMS with an option for one that would incorporate the vertical launch system. The Greeks were originally interested only in the trainable launch version of the Landsparrow, but later at the time of the request for the best and final offer in March 1981, and after the successful test firings at China Lake and Roosevelt Roads, they switched to the VLS. Since this newly developed part of the Landsparrow is of European origin, a major part of the final proposal effort fell to the Europeans (earlier quotes having involved simply informal planning numbers based on the trainable launch system followed by several short proposal extensions with 1 or 2% adjustments). This also required the European subcontractor to drastically modify their part of the proposal involving offsets. As the requirement gradually firmed up, the Greeks changed a few other things, such as mobility requirements.

Not only did Raytheon rely on the assistance of its European subcontractors in the overall marketing effort, but they had an important role to play in the offset part of proposal effort. (Unlike Raytheon though, the European firms also received the support of their respective governments.) The original offset package offered by the Raytheon led team was for work in the amount of 10% of the value of the contract. The work was to be in the form of an immediate direct offset (i.e. involving work on the Landsparrow system itself). The offset package eventually agreed to, however, was for 30% of the value of the contract and would involve both direct and an assortment of indirect offsets over an eight year period (e.g. maintenance contracts or agricultural products ordered by the selling industrial team and their governments).

As such decisions are wont to do, the selection of the winning contractor for the Greek air-base defense job slid several times. Political complications faced by the Greek government which held things up included: re-integration into the NATO command structure; U.S. base negotiations; an unexpectedly high CPI impact during phase-in to the European Economic Community; and recovery from a catastrophic earthquake. In the final stages of the competition the Landsparrow was the favored system and the Greek government was hoping to capitalize on the offset in obtaining a political concensus in support of the procurement. By late April, however, with unfavorable shifts in exchange rates as well as the rise in U.S. interest rates, the bottom fell out of Landsparrow's prospects. The contract went instead to the Swiss-Italian firm Contraves teamed with, interestingly enough, another division of Raytheon, the Missile System Division (Lowell, Mass.)[116]. The system was the Skyguard/Sparrow, for which Raytheon provided the missile, the launcher, and illuminator.

8. Transnational Ventures and Standardization at the Subsystem Level: Parallel Developments in the Automobile Industry

At this point it would be useful to step aside and take a look at another aspect of the problem, and how NSSMS fits into it. The NSSMS is significant to the development of transnational ventures in the defense and aerospace industries in yet another way.

An additional factor contributing to the Seasparrow's success in circumventing the numerous obstacles and booby traps lying in wait for such ventures, was that the system in one sense is only one system or (subsystem) of the multi-system complex represented by a destroyer, frigate or aircraft carrier. As covered in the introduction to Chapter 6 covering license production in Europe by a single national industry (Mode #1), the technology of the design and building of ships, unlike with most modern aerospace products, has allowed the smaller European nations to maintain their shipbuilding industries in tact. Both the differing economies of scale reinforced by the political strength of any such mature industry, have contributed to their continuing viability.

Producing ships of their own design however, is quite a different matter than coming up with the highly complex component systems. Here the opportunity for the smaller NATO allies to participate in the design and development of systems for which they have no feasible purely national alternative becomes attractive.

The U.S. Navy and Raytheon were able to successfully exploit this opportunity and eventually bring on board the majority of NATO navies.

Standardization at the subsystem level was to later offer a way out of the political embarrassment represented by the abortative attempt of the U.S. DoD to standardize on the next generation of main battle tanks with that of NATO's next largest tank force, the FRG. Following the bogus competition in which the U.S. Army (not too surprisingly) expressed its reference for its own creation, the USA/Chrysler XM-1 tank, over that of the Bundeswehr/Krauss-Maffei Leopard 2,[117] the U.S. proposed to salvage the effort by the less ambitious approach of standardization at the level of critical subsystems. This effort eventually led to the adoption by the U.S.A. of the Leopard 2's 120 mm Rheinmetall tank gun.

Much as several initiatives at the NATO organizational level during the 1950's (see Chapter 5) were all heralded as new developments of great potent for the future, so was the transnational Fokker-VFW merger of 1968. The ill-fated merger was viewed as a the logical follow-on to the recent spate of intra-national mergers in response to the multi-national challenge. Here too, though, something less glamorous and more workable would be required.

Similar initiatives and speculative waves concerning international economic integration have hit other industries, the automobile industry in particular. One such possibility that was popular back in the early 1970's was that of Fiat and Citroen, touted as a forerunner of a series of such mergers that offered the only feasible way for European car companies to attain the size necessary to survive in world-wide competition with GM, Ford, and the Japanese. Though at the time Renault was cited as an example of a firm that would be precluded from participating in this evolution because of its being state-owned, Renault

suffered no illusions or complexes on this score. Renault chose to follow a different course.

In common with the merger option, Renault's objective was to improve the economies of scale. Their approach however, was to attain this objective through joint ventures that contribute to either standardization at the component level, combining mutually supportive product lines to rationalize distribution and service networks , or license production arrangements. As of the spring of 1981 this involved among other partnerships:

- A joint venture with Ransburg (U.S.) (Cybotech) for robots that spray paint cars;
- 46% ownership of American Motors (AMC) which will distribute Renault cars and produce Renault cars under license;
- Ownership of 10% of Mack Truck which will distribute Renault's medium-size diesel-engined Midliner trucks, thus filling a gap in the Mack product line;
- A joint venture with Peugeot for producing automobile engines for the two French firms plus Volvo;
- A joint venture with Bendix (U.S.) - one which will produce electronic systems in France for cars.

Quoting from Robert Ball's article in the May 4, 1981 issue of Fortune:

> The purpose in every case is to gain economies of scale. Renault executives are fond of saying, "There is no world car, there are only world components." What they mean is that national tastes and driving habits demand the adaptation of models to individual markets, but that all those models can contain common elements-engines, transmissions, and axles, of course, but also electronic systems and even door handles.[118]

The underlying truths contained in the above paragraph are applicable the NATO aerospace industries, as well. The differing operational requirements of the national services, be they geographical in origin, or a matter of varying tactical doctrines and national funding 'capacities', are all the military equivalents of 'tastes' for such consumer products as automobiles. Which is to say, standardization can be most easily attained within an ad hoc grouping of like minded nations at the subsystem level.

Like Renault with its network of partnerships in the auto industry,* Raytheon has taken a lead in tackling NATO's increasingly complex industrial marketing environment. In addition to the NATO Seasparrow and SLMS projects, other interallied projects in which Raytheon, has, or is currently participating included: NATO Hawk, HELIP (European Improved Hawk), AIM-9L Sidewinder, Patriot, and Skyguard/Sparrow, to name but a few. The Seasparrow system alone is at the center of a mix of projects involving: interoperability (the Italian Aspide and American-German-Danish RAM); interchangeability (between the Raytheon and Hollandse Signal Apparaten fire control systems); and standardization (within the follow-on joint development Seasparrow Lightweight Missile System and possibly the Landsparrow variant). Thus we see the NATO Seasparrow team has successfully carved out a niche for itself in the highly segmented market place represented by NATO's component national government's, while simultaneously contributing to improved economies in the common and individual defense efforts.

The Renault and Raytheon strategies are both aiming at rationalization on an international level, but one short of integration.[119] This entails partnerships

on a venture by venture basis, but ventures focused on standardization at the subsystem as well as system level, further complimented by interchangeability and interoperability.

9. Conclusion

The NATO Sea Sparrow Surface Missile System (NSSMS) is the product of the combined engineering and development know-how of several NATO nations that, through working in concert, were able to bring the system from a design concept to a tested and proven reality. From among the wreckage of the various trans-atlantic codevelopment programs, the NSSMS stands out as a shining example of success, the only one of its kind.

Such a relationship as that established between Raytheon and its European partners during the NSSMS project is of long term significance. The trust built up and know-how accumulated since engineering development was launched in 1969 is an intangible benefit of much value. The SLMS joint development project is a more recent manifestation of this established relationship and should serve as the forerunner of many a future transatlantic project.

The NSSMS project represents a significant step in the direction of improved NATO RSI, with R&D, operational and logistical advantages emanating from its being a commonly held system, as well as the industrial, technological, employment, and BOP advantages of jointly developed and/or produced system for all members except the latest customers, the FRG and Greece. The program also demonstrates the effectiveness of the post-1966 NATO cooperative R&D, and production procedures. All of these in turn contribute to that very important intangible, Alliance solidarity. Yet, still more important than all of the above, remains the simple fact that this is the only major transatlantic program involving the joint industrial development of a weapon system under contract to a consortium of buying governments including the U.S., that has

succeeded. No small feat. So, what then are the factors that contributed to the program's success?

10. Lessons Learned

(1) The impetus for the program came from a commitment on the part of the U.S. to provide tangible support for the new set of NATO procedures for cooperative R&D and production. Thus, the U.S.N. went through NATO from the beginning and was willing to add that important ingredient (be it no panacea) -'political will.'

(2) These new procedures in turn, proved to be a practical instrumentality for furthering these aims, as exemplified by the success of this first of the cooperative development and production programs to originate from within them. Though the comparison is not completely fair since this involved a much less expensive system, this success can be contrasted with the fate of NBMR 3 and NBMR 4[120] early in the 1960's under the older procedures.

(3) Early identification of the system configuration, and as such, approximate cost and schedule. In contrast to the Mallard, MBT-70, and AVS[121], the participating nations knew at the outset what they would be getting, and when they'd be getting it. The U.S. Navy offered the Sparrow III air-to-air missile to the NNAG as a starting point for the program, providing the basis for concentration on a specific configuration. The participating nations were able to reach agreement on a particular configuration based on prior U.S.N. studies.

(4) The early selection of Raytheon as prime contractor further assisted the governments in the configuration selection process. Raytheon was the

logical choice[122] since the Sparrow III was a Raytheon designed missile, and also because of their previous experience of working with European industry for the multinational licensed production of an earlier SAM system, the U.S. Army/Raytheon Hawk.

(5) There was early agreement as to cost sharing and allocaton of work among the participating countries. This encouraged them to proceed with detailed planning and early commitments to the program. When a country was unable to make commitment, it participated as an observer - only those nations having made financial commitments participated in decision making. This also discouraged countries from delaying their procurements to avoid paying their share of the development cost (e.g., the Netherlands and Belgium came in late and so were excluded industrially from into the development phase but still paid their share of development costs for participation in the joint production phase).

(6) In the management of the program there was a clean chain of command, from the Steering Committee to a single program manager and project office, to a single firm acting as prime contractor with maximum authority and responsibility vis-a-vis the multinational industrial consortium. A point to be contrasted with the MBT-70 and Mallard experiences.

(7) A general consequence of the above factors was that there was a minimum of change throughout the project.

(8) The incorporation of European industry into the engineering development phase as well as the initial sole source production phase several years later was not only accomplished on a rational basis, but also created a significant industrial stake for all participants in the project and contributed to the continued viability of the project throughout both phases. This is a vital point, especially in comparison with the NATO PHM project.

(9) The continuity of the U.S. Government personnel involved in the program contributed considerably to its smooth functioning and consistent support from within the U.S. Government.

(10) The collaboration of European firms in development and production was excellent, involving no significant cost increase. Closely interrelated with (3) (4) (5) and (8) above, this was due in good part to Raytheon's having been given the time from early-on in the program for proper planning, but also was a function of its ability to centrally manage the limited number of European subcontracts (just compare this to the time scale and complexity of the F-16 effort). The numerous 'lessons learned' contributed by the project in the area of transnational subcontract management are treated in the 20 pages of section 4 of this sub-chapter.

(11) The plus or minus 25% zero Balance of Payments (BOP) rule provided considerable flexibility in maintaining a rational distribution of work, while still allowing for minimal BOP disruption.

(12) The technological and industrial capabilities of the participating European industries were a good match for the work packages received.

(13) The predominant weight of the U.S. financial/order share in the program (e.g., originally 83.6% of R&D funding) has allowed for proportionate European industrial participation while the major part of development and production could still take place in the U.S.

(14) Closely intertwined with (13) above is the sub-grouping of NATO member states that are both capable of, and willing to, participate as minor partners with the U.S. in joint projects, the four smaller northern European members, plus Italy. This is much less feasible for the alliance's three medium powers, France, the FRG, and the U.K.

(15) This was not a primary high prestige weapon system on the order of a fighter plane (AVS or AFVG) or a tank (MBT-70), where it becomes much more difficult to reconcile the views and interests of the various armed forces vis-a-vis the nature of the requirement, as well as the much larger industrial and financial stakes involved, i.e. something on the order of a successful ecumenical movement was not required.

(16) This program provides an ideal model for future transatlantic joint development programs within the framework on the "Family of Weapons" concept where a single nation takes primary responsibility for developing a system while sub-contracting out 20 or so percent of the work to foreign industry. A workable compromise that neatly circumvents the old impasse over

differing U.S. and European philosophies with regards to cooperative development.[123]

(17) There was no competing alternative system available that could at least partially fill the participating nations' military requirements. This can be contrasted with the MBT-70 where the FRG had the Leopard I to cover its needs adequately enough through the 70's, or with the PHM project where the FRG had the purely domestic alternative of a conventional patrol ship, oreven in the case of the Anglo-French variable geometry (AFVG) fighter where France had a solely domestic back-up system in the Mirage G.

(18) No disruption was introduced through substantial differences in replacement schedules among major participants; differences that have to be reconciled if a steady support base is to be maintained. For NSSMS this was a non-issue primarily due to the predominance of one nation's share of the orders.

(19) The fact that the system was one of a family of 3 point defense surface missile systems being worked by the USN, helped to make the program's vulnerability (i.e. due to its dependence on foreign participants) more acceptable to the USN.

(20) The NSSMS was only one of a number of subsystems (be it a key one) for the multi-system complex represented by a ship. Each of the ships were them-

selves of national design. The practicality of this is somewhat peculiar to navies, due to the nature of ship building, but does apply to a lesser extent to the other services as well.

(21) The follow-on SLMS project provides an important model for future joint development projects of a similar scale. Building on the working relationship established during the NSSMS project, this international industrial team is developing the new system without government participation. This time around the firms are risking their own capital, and as such work sharing is not a function of government funding, or future orders.

[1]John Marriott, "Defense Against Air Attack at Sea," Military Technology, p. 76.

[2]Britian and France have a different concept of point defense. They consider that point defense missiles do not need a long range and are thereby able to keep the missile small, which in turn reduces the size of the launcher and makes the system somewhat more flexible. The U.S. on the other hand relies on its Tartar and Sea Sparrow systems with ranges of 15-25 km. (Marriott, op.cit., pg. 75).

[3]Interestingly enough, it was the license production of another Raytheon surface-to-air missile (SAM) system in Europe during the first half of the sixties which made development of the competing Naval Crotale possible, the U.S. Army/Raytheon Hawk medium altitude SAM. It was Thomson-CSF alone, among the five National Prime Contractors of the NATO Hawk program, that fully digested the know-how transferred during the project, and thereby could build up from this base in the development of its own low altitude SAM system (an example of the long term effects of the dissemmenation of technology). See Chapter 7 for the NATO Hawk project history.

[4]Tom E. Moore, Launcher System Manager and Project Historian, "The NATO Sea Sparrow Surface Missile System," International Defense Review, 1/1974, p. 52.

[5]Ibid., p. 53.

[6]See Appendix X, C-M(66)33, pp. 3-5, and Chapter 5, for a discussion of the shortcomings of the NBMR procedures. NBMR 39 is treated in Chapter 8.

[7]Melvin T. Baas, United States Involvement in Codevelopment: An analysis of the US/FRG V/STOL Fighter Aircraft and NATO Sea Sparrow Project, a thesis presented to the Air Force Institute of Technology 1, August, 1971, p. 41.

[8]Ibid. P. 42.

[9]For the document, AC/259-D/513, covering "Policy Guidance, Organization and Method of Work for the NNAG", see Appendix XI.

[10]Baas, op. cit., p. 36.

[11]Ibid., p. 37.

[12]Ibid.

[13]Charles D. Allen, Capt. USN, First NATO Seasparrow Project Manager, "NATO Sea Sparrow," U.S. Naval Institute Proceedings, July, 1969, p. 145.

[14]The selection of Washington, D.C. was a function of the prime contractor having been American which is, in turn, a function of the systems origin and the U.S.N. being the primary customer.

[15]Thomas E. Peterson, Raytheon's NSSMS assistant Project Manager for International Operations, interview with the author, January, 1978.

[16]It is the Danish representative that wins the prize for longevity, having sat on the Steering Committee continuously from 1968 to 1981.

[17]Moore, op. cit., p. 54.

[18]Peterson, op. cit.

[19]Quoting from a letter to the author from: Thomas E. Peterson, Assistant Program Manager - NSSMS, International Operations, Raytheon. Naturally this difference is in good part a function of the scale of the two projects.

[20]Moore, op. cit., p. 53.

[21]Allen, op. cit., p. 147.

[22]Norway originally planned to procure 16 systems, but later reduced this to 6, thus paying a proportionately larger share of R&D costs than would have otherwise been the case. The U.S., as well, was to drastically reduce its planned procurement, with similar consequences.

[23]Moore, op. cit., p. 54.

[24]The list of 14--Raytheon, Frequency Engineering Laboratories, Bendix, Chrysler, G.E., Goodyear Aerospace, Hughes, Lockheed, LTV Aerospace, North American Rockwell, RCA, Singer-General Precision, Sperry Gyroscope, and Texas Instruments. (Note that since all competing contractors were from one nation, the U.S., all participants were politically indifferent to the ultimate choice.)

[25]Moore, op. cit., p. 54.

[26]Ibid.

[27]Baas, op. cit., p. 38.

[28]Allen, op. cit., p. 146.

[29] Though the figure $40 million has also been mentioned.

[30]The incentive guarding against an overly low original estimate was, naturally enough, the industrial share that goes along with the funding share.

[31]All customers outside of the original four countries that launched the program have opted to procure a Dutch fire control system instead of the Raytheon system and thereby procured only the NSSMS transmitter plus an NSSMS launcher. In addition, several customers eventually procurred the Italian Aspide missile for use with the system.

[32]Allen, op. cit., p. 146.

[33]Ibid., p. 147.

[34]The one exception was the Low Light Level Television System, designed and produced by associate contractor Ball Brothers Research, Boulder, Colorado.

[35](Interview with Steve Rowen, Raytheon's Corporate Director of Contracts, January 1978.

[36]Moore, op. cit., p. 51.

[37]K.V. and the Norwegian Defense Research Establishment had developed during the 60's the Penguin MK-1 surface to surface missile, one of the first representatives of a new generation in naval armament. The Penguin's warhead was the same as that of Bullpup for which KV had been prime contractor for the NATO-European production consortium. The missile has a range of about 20 km. and received U.S. government (MWDP) and FRG financial assistance, along with technical assistance from the U.S. Navy.

[38]Baas, op. cit., p. 43.

[39]Peterson, op. cit.

[40]Moore, op. cit., p. 51.

[41]Ibid.

[41]To place this production activity in perspective, it is useful to keep in mind the corresponding time scale of the largest transatlantic joint production program of the 70's, the F-16 multinational fighter. Several points of comparison between the two include:

- the NSSMS included the same grouping of national industries as the F-16, except that, up to early 1979, the NSSMS also included one Italian firm.
- the much larger scale and higher visibility of the F-16 program;
- the F-16 joint production effort was two and a half to three years behind that of the Sea Sparrow;
- the F-16 joint production effort was not preceded by joint industrial development;

During 1975 when the F-16 program people from the U.S. government were finalizing the MOU and U.S. industry was initiating the source selection process on the other side of the Atlantic, this relevant precursor, the NSSMS, was initially overlooked. This was a result of the smaller scale and lower visibility of the NATO Seasparrow program, plus the fact that it involved another service. It was not until the U.S. teams got over to Europe and began working the details of implementation on site, that they were introduced to the NATO Seasparrow program. The latter program was constantly cited in referring to relevant precedents for the F-16 effort. Upon return to the U.S., the ASD at Wright-Patterson and several of the U.S. firms began to actively tap the NATO Seasparrow program's accumulation of know-how. Two firms in particular proceeded to pick Raytheon's brains in early 1976; Pratt & Whitney and Delco.

At Raytheon's European sub-contractors the two programs crossed paths as those seven among the eight that were located in the F-16 participating nations began to be severely exercised, being inundated with U.S. industry survey and negotiating teams. The experience that had been gained by these seven common European subcontractors during the early years of the NATO Seasparrow program was later to make life easier for the F-16 program.

[42]Later acquired by Dannebrog, which then sold it to B&W Elektronik.

[43]Value of subcontracts granted for Lots I and II (the initial production effort and the period during which offset was mandatory) ÷ national orders from Lots I and II.

[44]Value of subcontracts granted through November, 1979 ÷ national orders from Lots I and II.

[45]The Netherlands' post-Lot II purchases altered this figure considerably, since they later increased their original order base of 6 systems ($9.6 million), by another 12 ($28.3 million). When this additional purchase is figured into the numerator it reduces the 158% of BOP figure to 54%. Including orders after Lots I and II does not change the other nations' BOP percentages all that much.

[46]This is not to ignore the existence of low level on-going pressure from within Raytheon to bring work back in-house.

[47]Interviews with the late Jim O'Brien, Raytheon's NSSMS subcontract manager, February-April, 1981.

[48]Instead of 1 fire control system (FCS), 1 launcher and 1 transmitter (radar) as with the single systems, the dual system has a 1-1-2 combination, i.e., with twice as many transmitters, twice as many targets can be tracked.

[49]Two options are offered on the FCS, either the standard Raytheon system, or the Dutch Hollandse Signal Apparaten (HSA) WM/25 system plus an NSSMS transmitter and guided missile launch system (GMLS).

[50]The upcoming deliveries of the NSSMS to the USN will involve a newer sparrow missile, the RIM-7M. This missile is covered later in the sub-chapter.

[51,52]Denmark and Norway each have a single system at a land-based site used for training and testing.

[53]Greece is buying a new frigate equipped with the NSSMS from the Dutch.

[54]Peterson, letter to the author, October, 1979.

[55]Behrman, op. cit., p. 13.

[56]Ibid., p. 14.

[57]MBLE was selected because Raytheon felt its management was stronger, as well as its several million dollar bid being some $7,000 less than that of ACEC's. This proved to be an especially fortunate choice, since three months later ACEC was hit by a strike that lasted some 18 months.

[58]O'Brien, op. cit.

[59]Peterson, interview with the author, January 1978.

[60]Source control drawing (SCD).

[61]This is not to ignore the value of the technology and know-how being transferred. Even if these loadings were seriously reduced or eliminated, they would more often than not be replaced by technical assistance fees, licensing fees, and royalties to compensate the U.S. firm for the technology and know how being transfered, i.e. the U.S. first tier sub would become licensor instead.

[62]O'Brien, op. cit.

[63]Ibid.

[64]Ibid.

[65]Ibid.

[66]Ibid.

[67]Ibid.

[68]Peterson, interview with the author February, 1981.

[69]Ibid.

[70]Ibid.

[71]Jim O'Brien reflected however, that even though Cartwright was limited in who he could talk to in the European firms and thereby could not have operated at the level required to be effective in dealing with his counterparts, this did not necessarily have had to have been the case. Once his status and

authority had been established, Cartwright or an equivalent, could have possibly operated effectively at the proper level.

[72]Peterson, op. cit., February, 1981.

[73]Ibid.

[74]Ibid.

[75]Ibid.

[76]Ibid.

[77]Ibid.

[78]O'Brien, op. cit.

[79]Again as a function of the smaller size and less visibility of the program site surveillance and signatory authority for DD 250's never become an issue for the NSSMS, unlike the F-16.

[80]Ibid.

[81]Peterson, letter to the author July, 1981.

[82]O'Brien, op. cit.

[83]Ibid.

[84]High volume U.S. Mil Std parts are being increasingly stocked in Europe on a commercial basis, due to the increasing number of joint programs.

[85]O'Brien, op. cit.

[86]Foreign Currency Agreement (F-16) in Support of Multinational Programs, Project Number 79-065 (ANW), prepared by ASD/XOR Andrews Reserve Officers (AFSC).

[87]Ibid.

[88]It is expected that the Advanced Medium Range Air to Air Missile (AMRAAM) will use the prime contractor to make currency conversions and payments in a manner similar to NSSMS.

[89]Peterson, op. cit., February, 1981.

[90]O'Brien, op. cit.

[91]Peterson, op. cit., January, 1978.

[92]O'brien, op. cit.

[93]Peterson, op. cit., July, 1981.

[94]O'Brien, op. cit.

[95]Peterson, op. cit., July 1981.

[96]Ibid.

[97]All non-U.S. customers currently utilize Cooperative Logistics Supply Support Arrangements (CLSSA/FMSO I & II).

[98]Unlike several earlier collaborative projects there has always been on ample supply of spares, logistics planning having received timely attention. From day one, all participants provided money for an initial two-year supply of spares.

[99]Covered in Chapters 2 and 3.

[100]Harold Brown, Rationalization/Standardization within NATO, Sixth DoD Report to the U.S. Congress, January, 1980, p. 49.

[101]Bruce A. Smith, "RAM to Offer Antiship Missile Defense," Aviation Week & Space Technology, December 11, 1978, p. 53.

[102]Ibid.

[103]Ibid., p. 55.

[104]Ibid.

[105]Ibid., p. 53.

[106]Ibid., p. 53

[107]Ibid., p. 58.

[108]Ibid., p. 55.

[109] Marriott, op. cit, p. 76.

[110]Neither of these two follow-on developments are part of the NATO program. The governments are not direct participants. These are both industry-to-industry ventures.

[111]Here we're looking at an international teaming identical to that of the F-16 joint production project (i.e., the same 5 nations).

[112]For an explanation of the IEG's see Chapter 5 or NATO Document AC/259-D/513, "Policy Guidance, Organization and Method of Work for the NNAG and its Subordinate Groups," Appendix 1, page 1.

[113]Memorandum of Understanding for International Development of the Seasparrow Lightweight Missile System (SLMS), Sections V and VI.

[114]Dutch industry (collectively Fokker and Bronswerk) is the largest non-U.S. participant, accounting for 40% of the $5 million in total European investment.

[115]"Seasparrow VLS System in Successful Sea Demonstrations," Aerospace Daily, April 24, 1981, p. 319.

[116]Contraves was able to offer 8% financing as compared to U.S. rates in excess of twice this.

[117]To be produced under license by FMC, if selected. Both projects were national offshots of the previous joint MBT-70 project of 1963-1970 (an earlier subchapter of this Chapter).

[118]Robert Ball, "Renault Takes its Hit Show on the Road," Fortune, May 4, 1981, p. 280.

[119]Unlike Renault though, Raytheon has retreated from its policy of the late 50's/early 60's of encouraging equity participation in firms on the other side of the Atlantic, showing instead a marked preference for a collaborative, project by project approach (Rowen, op. cit.).

[120]NBMR 3 and NBMR 4 are treated in Chapter 5.

[121]All three of these transatlantic joint design/development projects are treated earlier in this chapter.

[122]In spite of having to resort to a competitive bidding for the engineering development contract after the contract definition phase, which Raytheon won anyway.

[123]With the DOD's policy of supporting interdependent R & D, the work is unilaterally funded and carried out within one nation, with the end product being available to all partners to the agreement for license production. However, Europe's three medium powers (France, the FRG, and the UK) emphasize the vulnerability of such programs to unilateral cancellation as well as the loss of the technological capabilities generated through the R&D effort. Therefore the Europeans have preferred 'joint' development over the U.S. preference for 'interdependent' development.

The G.E./SNECMA CFM-56 ENGINE

The CFM-56 engine was developed jointly on a 50-50 basis by General Electric of the U.S. and SNECMA of France for use on commercial air transports. The CFM-56 utilizes the core components of the F101 engine developed by G.E. for the USAF with minor change, combining it with a SNECMA designed and developed fan and fan turbine to create the CFM-56. For France the engine represented its first foray into the world commercial air transport jet engine market.

While still under development, interest in the engine began to shift more towards its military applications. The engine was first included in a package of industrial collaboration alternatives offered to a NATO consortium for its purchase of the E-3A AWACS, a system utilizing a militarized version of the 707 for its air vehicle. It represented the major portion of the work offered from 1975-78 to the French if they were to participate in the NATO purchase. Though France was active in the NATO planning efforts and reportedly on the verge of coming in several times over the three year period, when participation in the government consortium making the buy was finally firmed up in late 1978, France was out. Consequently, the NATO fleet of 18 E-3A's is being produced with Pratt & Whitney TF33 engines, as have been those of the USAF.

Instead, in January 1980 the CFM-56 engine was finally kicked off by another major military program, the re-engining of the USAF, and (later in the year) French Air Force Boeing KC-135 tankers. The USAF was planning to re-engine at least 300 of the KC-135's and France all eleven of its C-135F's.

The CFM-56 engine project was launched in the fall of 1971, after the French government selected General Electric over United Technology's Pratt & Whitney as the SNECMA's partner for joint development of a new 10-ton engine (the French government is majority shareholder of SNECMA while United Technology is a minor shareholder). For the French government this was part of a strategy of strengthening its national aerospace industries; SNECMA being the number two aircraft engine producer in Europe with 6% of the free world market for gas turbines (1977 sales) compared to 16% for Rolls Royce. G.E. also had a #2 status, with 19% of the free world market against United Technology's Pratt & Whitney with 39%.

As the #2 U.S. and free world producer, G.E. had adopted a strategy of "share-the-market-to-gain-total-market" to improve its market position against the dominant commercial producer, Pratt & Whitney. G.E. pursued its own "brand" of international sales involving various licensing and subcontracting arrangements (with the latter being both integrated co-production as well as second sourcing) an area where Pratt & Whitney had been much less active, at least until the mid-70's.

In response to the question as to whether there was any particular reason why this high degree of collaboration which has appeared in the aircraft engine segment of the U.S. aerospace industry before other segments, G.E.'s Bill Bodenbaugh offered the peculiarity of the place of the engine within the total aircraft as the possible cause. Engine producers, as the subcontractor providing a major subsystem that is optional, are also providing one that is significant enough to offer a tempting target for demands of offsetting industrial participation.

Within the general framework provided by the relative strength in the commercial aircraft engine market of its principal competitor and the nature of engines within the range of aerospace products, the international environment also provided a number of stimuli to G.E. planning with regards to its commercial engine development programs. G.E. needed a foreign industrial partner in light of two major stimuli:

- the need of such a partner for market penetration, and;
- R&D costs.

G.E.'s revised CFM-56 Proposal of March, 1973, to the State Department's office of Munitions Control (OMC), one directed at convincing the U.S. government of the merits of the joint program, elaborated on these two points.

> The increasing nationalism of most world governments and the interlocking user/manufacturer/government-sponsor relationships that exist within geopolitical areas. . .the European Economic Community being a prime example. Also, in several instances, single, national companies have been formed by combining several independents for merged strength. In addition, companies within the EEC can get together and form consortia whereas U.S. anti-trust laws prevent such activity by U.S. firms (e.g., imagine G.E., Pratt and Whitney, and Allison getting together and forming a consortium).[1]
>
> Within the commercial aerospace arena (historically a very strong positive balance of trade market) the effects of reduced U.S. Military R&D sponsorship coupled with the rapidly rising risk capital requirements of major new programs are hindering traditionally strong U.S. corporations in fitting their reinvestment capability with the market opportunity timing.

The proposal continued:

This resulting competitive environment calls for a "share-the-market-to-gain-total-market" plan and is the strategy on which this CFM-56 engine is based. The points noted below appeared to be most pertinent in the formulation of this strategy.

- The U.S. trade balance remains negative for foreseeable future.
- Attractive U.S. exportables include high technology areas.
- Overseas governments are dedicated to self-improvement in high technology areas.
- U.S. must find a business relationship overseas in high technology which will assure a positive U.S. trade balance.
- General Electric has shown positive results from a strategy of joining/sharing in high technology product areas.

The need for the revised proposal referred to above brings us to one of the two interesting aspects of the project that will be mentioned here—the U.S. government's concern over the technology aspects of the program. In August 1971 G.E. received a 12 month export license from the State Department's Office of Munitions Control (OMC) which administers the International Traffic in Arms Regulations (ITAR), allowing for the discussion of CF6-50 level component technology data for purposes of initial CFM-56 design. In May, 1972 requests were submitted by G.E. for an extension of this technical data license, along with an application for a core hardware export license. The OMC issued a technical data license extension, with certain limitations attached, but the request for the hardware license was refused. This halted further work on the precedential G.E./SNECMA effort.

G.E. set forth a solution to the impasse in its Revised CFM-56 Proposal of March, 1973, one which it felt accommodated the central U.S. government concern—the timing of the F-101 core hardware export (the F-101 being under development for the USAF's B-1 bomber) and the protection of U.S. technology embodied therein.

After explaining the rationale for its "share-to-gain" concept previously referred to, the revised proposal went on to make its case with regards to the CFM-56 specifically. Within the world market for aircraft gas turbines, the commercial market was the major growth segment, significant participation in this segment being attractive and necessary to generate the reinvestment capital that would be needed to keep the major suppliers strong. More specifically, the need for the "10-ton" engine stemmed from the need:

- for an increase in productivity in the short/medium range market to handle growth in Revenue Passenger Miles;
- to incorporate advances in low noise and low emissions, and;
- for improvement in the relationship between operating costs (i.e., fuel and labor) and revenue.

G.E. pointed out that within this predicted marketplace for the new engine, 60% was likely to be sold outside the U.S.—with an even higher percentage being sold off-shore in the early years. Pointing to the success of its previous pursuit of a "share-to-gain" concept with regards to license production of its military aircraft engines (the F-104's J79) overseas during the 60's; as well as the concept's more recent expansion to such arrangements in the early 70's that included:

- the creation of a Turbomotori a joint venture in Italy with two Italian firms as sales and service agent for G.E. power plants, with a charter providing authority for eventual design and construction of power plants, and;
- the CF6-50/A300 co-production arrangements.

G.E. next, developed its argument in the revised 1973 proposal through establishing a definite trend towards a reduction in the lag of EEC engine technology to that of the U.S. over time— a principal reason being that, "for a particular engine family, the rate of improvement of fundamental technology slows as that type of machine matures after the initial 'breakthrough.' Thus, we find the EEC inevitably closing the gap."

G.E. concluded its case by pointing to the advantages it offered with regards to military programs, the U.S. research and development base, and U.S. industrial preparedness.

The military uses foreseen at the time included:

- a favorable impact upon B-1 acquisition costs, and;
- offering itself, either on an off-the-shelf basis or through a derivative, for the replacement aircraft for such military transports as the USAF's C-130's and Franco-German Atlantic, Noratlas, and Transall.

As regards the U.S. research and development base and industrial preparedness, G.E. made the following points (which were to become, when adopted several years later by the U.S. government, an important part of the reasoning involved in the selling of NATO RSI to opponents in industry, labor, and government). After first pointing out that the U.S. government's sponsorship of aircraft engine R&D (besides providing an insecure market place) was expected to settle out at a new, lower level during the 1970's as compared to the previous decade, it continued:

> "To remain technologically competitive, corporate reinvestments (IR&D sharing, margin on commercial programs, etc.) must play a more important role in maintaining U.S. technology leadership."

This joint GE/SNECMA program was represented as a positive step in that it:

- o released G.E. discretionary funds for advanced research and development, and;
- o CFM-56 production would generate over $100 million of IR&D sharing funds.

And with regards to industrial preparedness:

> Retention of a viable manufacturing base is critical to the U.S. engine industry. Major U.S. participation in the growing overseas market is best assured by the share-to-gain approach to the "10-ton" engine. The positive trade balance that results from this concept means more U.S. jobs are retained in our industrial base than if the EEC were to "go it alone.

Therefore, after presenting all the business imperatives behind the project, G.E. proposed to revise the program to protect the core technology by delivery of a sealed core to SNECMA at a date 18 months later than originally proposed. More specifically this would involve, among other changes, the transfer of systems management from SNECMA to G.E. and all core manufacturing and assembly being accomplished in the U.S. by G.E., with no internal core engineering data being measured during testing in France.

The OMC and DoD[2] found this second proposal to be acceptable and the hardware export license was issued for the sealed core of the CFM-56.

The compromise referred to above is an example of the necessity, as well as possibility, of finding a way to building a balanced arrangement that can provide maximum protection for each country and company involved in the transnational enterprise. As the revised proposal accommodated the concerns of the U.S. government in a manner acceptable to the other participants, a revenue sharing as opposed to profit sharing, scheme was devised that dealt with a

primary concern of the industrial partners. G.E. and SNECMA adopted a mechanism that reduced that part of the project's risk resulting from its "joint" nature—i.e., the vulnerability of each partner to having to pay for the problems of the other. In order to avoid the resultant undermining of accountability, a system was needed that could effectively insolate each party on this point. In dividing up the work a clear division of responsibilities was possible—G.E. for the core, and SNECMA for the fan and fan turbine. Cost responsibilities could therefore be divided up and fixed within the project and total revenue (not profit) could be shared on a fixed percentage basis. This fixing of costs then resulting in two independent profitability equations. Therefore, on a cross-borders basis, costs were fixed, leaving the individual firms (or the national governmental budgets) to cover any excess costs.

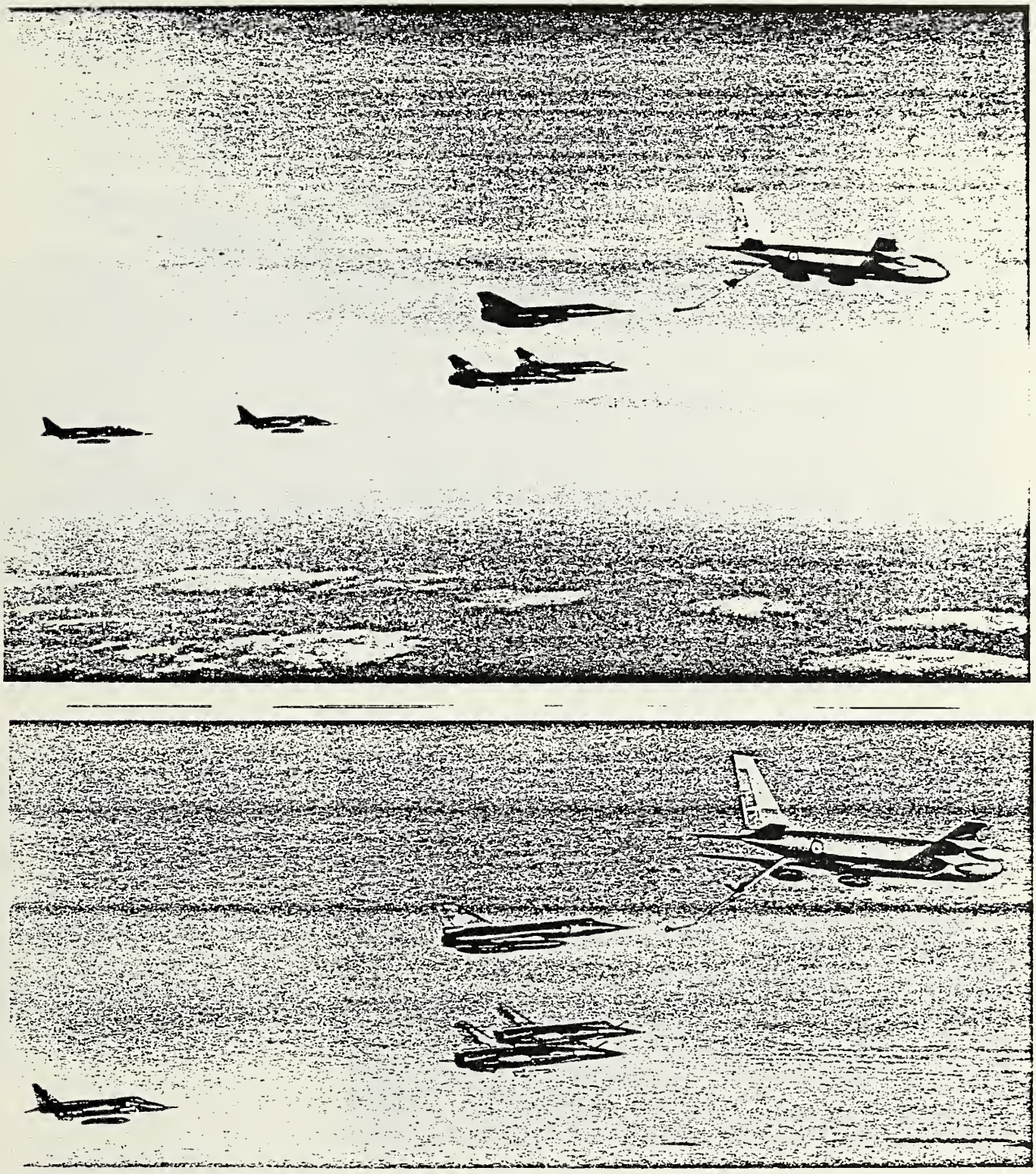
The responsibilities for the CFM-56 are divided more or less equally between General Electric and SNECMA, with CFM International providing overall program management: General Electric being responsible for the core engine and the main engine control system and also for design integration; while SNECMA is responsible for the low pressure system, the thrust reverser, gearbox, accessory integration and engine installation.[3]

CFM International negotiates contracts with customers and subcontracts manufacturing to the two parent engine companies. SNECMA and General Electric will each build the parts which they have developed. There was no planned duplicated manufacture, but there will be two assembly lines, i.e., engines for the U.S. market were being assembled by General Electric, and those for

the French by SNECMA. However, because of the CFM-56's modular design concept, assembly only represents about two percent of the total volume of work.

For a project management team, the joint venture has a rather small staff, relying heavily on the two parent firms. As an example in late 1976, although CFMI negotiated contracts with customers, there were only four marketing people on the staff, most activities in this sector being undertaken by General Electric and SNECMA personnel who follow instructions from and act on behalf of CFMI. The two companies did not expect CFM International to grow a great deal, remaining purely a project management team for this one project.[4]

In line with the revenue sharing principle, there is no flow of money and no comparison between the costs of production in Europe and the United States. In effect, the total price paid for an engine is split into several different, unequal amounts. CFM International takes a small part to cover its costs, SNECMA and General Electric each take 50 percent of the sum allocated to recoup development expenditure, while they also share, not equally, but on a basis of their respective contributions, an amount allocated to cover marketing and product support costs. Finally the production value allocation is split to give a certain percentage to SNECMA to cover work on the low pressure components and another percentage to General Electric to cover work on the high pressure section, while yet a third percentage goes to whichever of the two companies is responsible for final assembly and testing of the particular engine. There is a profit in each of the different categories.[5]

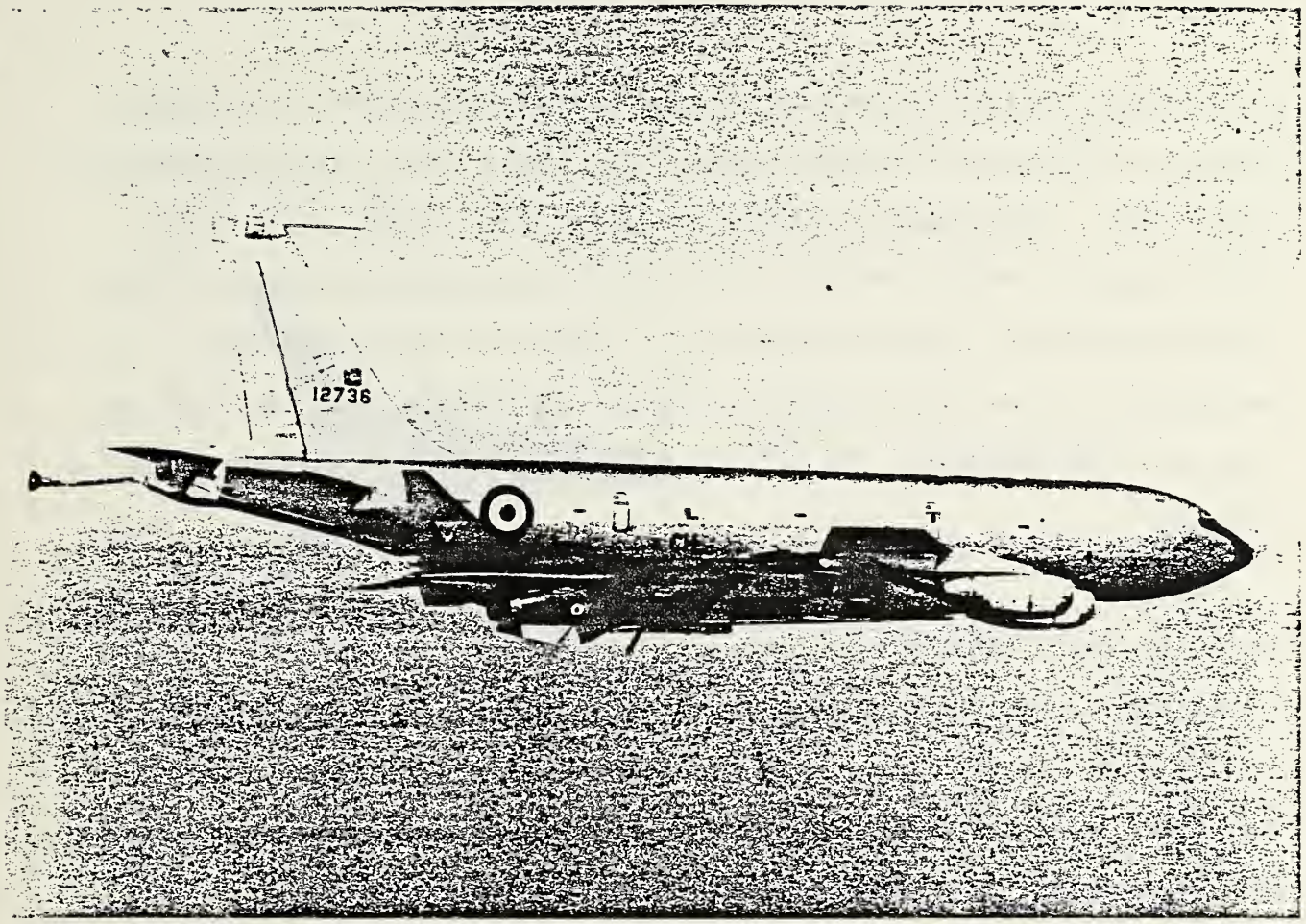


Capables d'être ravitaillés en vol, un Mirage IV A des FAS, deux Mirage F1C de la Défense aérienne et un Jaguar de la Force aérienne tactique (Adj C Degoul Sirpa Air).

In summarizing several of the more salient conclusions that could be drawn from the accumulation of experience by G.E. in the area of licensing and technology transfer, in a January 1978 interview in Lynn, Massachusetts, Bill Bodenbaugh of G.E.'s Aircraft Engine Group cited the following:

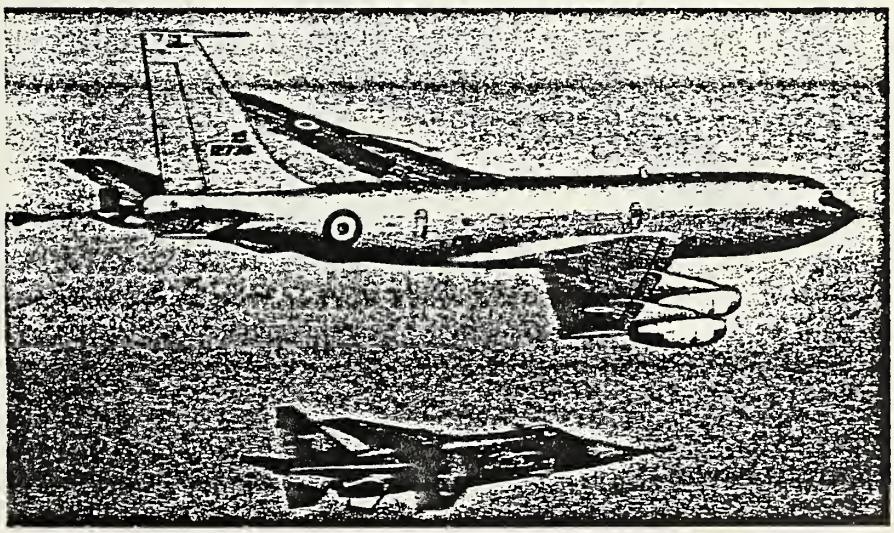
- Ever since its first licensing agreement with Rolls Royce for the T-58 engine, GE has found that it has received a very important flow-back in technology from its foreign licensees.
- The fear of creating future competitors through licensing the transfer of technology is usually unfounded, mainly due to the foreign licensees incapacity to fully digest the transferred technology. This is further complicated by the need to learn the rigorous quality control which is concommitant with the transferred technology. This seriously impacts the cost of gearing up for 100% production of a given end item.
- It is on the sale of follow-on technical assistance, not the royalties on Maintenance, Overhaul and Repair (MOR) licenses, where a licensor makes the money.

In the late 1970's, Boeing, SNECMA, and General Electric conducted successful development and flight test programs utilizing a 707 aircraft and CFM-56 engines. CFMI and Boeing each contributed $25 million to the joint program. Following its first flight in November 1979, the Boeing 707 CFM-56 equipped test vehicle completed 84 flights and 164 test hours. The program reinforced the position of the CFM-56 as a logical candidate for updating several military and commercial aircraft.



Dans l'aile d'un C 135 F de la 93e Escadre de ravitaillement en vol, un Jaguar de l'Escadron de chasse 4/7 "Limousin". La fin de la mission des deux appareils comportait une approche en formation vers leur base mère : Istres (Sgc J.P. Gauthier Sirpa Air).

• **C135 F** *(KC) - Ravitailleur (+ transport) - 31.08.56/27.01.64 - E 39,87 m L 41,50 m H 12,70 m - 136 000 kg - 15 000 m - 900 km/h à 10 000 m - Quatre réacteurs Pratt et Whitney "J57P-59W" de 5 750 daN chacun - 2 500 m D/1 800 m A (2) - Deux pilotes, un navigateur, un opérateur ravitailleur - Capacité de 10/40 tonnes de carburant à transférer pour un ravitaillement à 2 500/4 500 km avec retour base - Dès 1985 les C135 seront remotorisés avec des réacteurs franco-américains CFM 56 de 10 tonnes de poussée qui amélioreront notablement ses performances - Boeing (E.U.).*



As previously mentioned, the USAF selected the CFM-56 turbofan for its USAF/ Boeing KC-135A tanker aircraft on January 22, 1980 for the re-engining development program. The competing solutions were for the JT8D-209 or the TF-33, both proposed by Pratt & Whitney. The CFM-56 was selected because it offered higher performance, lower life cycle cost, less noise and easier support. The new 22,000 lb-thrust engine improves take-off performance, increases fuel payload and lengthens range. The CFM-56 will almost double the tanker's refueling capacity.[8]

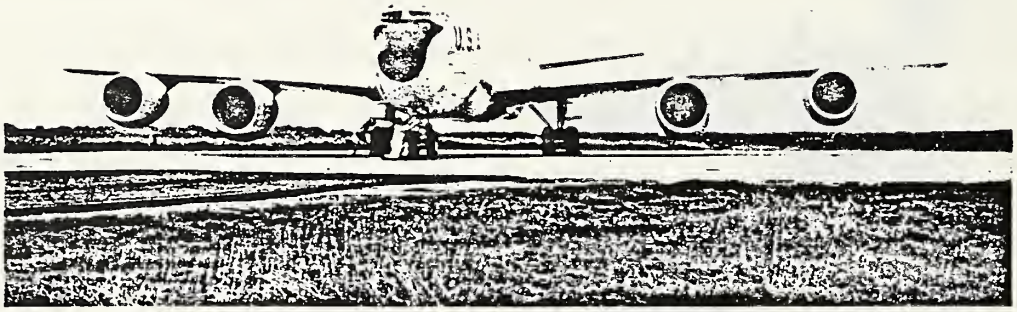
The selection of the CFM-56 was announced simultaneously with that of the award to Boeing of a $13.6 million contract for planning, preliminary design and developmental testing of one re-engined KC-135A tanker equipped with CFM-56s. Two months later the House Armed Services Committee's subcommittee on procurement recommended authorization of $60 million for procurement of production tooling and long-lead materials to initiate the KC-135 re-engine program.

The importance of this program is readily apparent when one considers that the USAF operates some 615 KC-135s, the military precursor of the commercial Boeing 707.[6] Another 11 C-135s are operated by France's Armee de l'Air, the only foreign customer of the system.

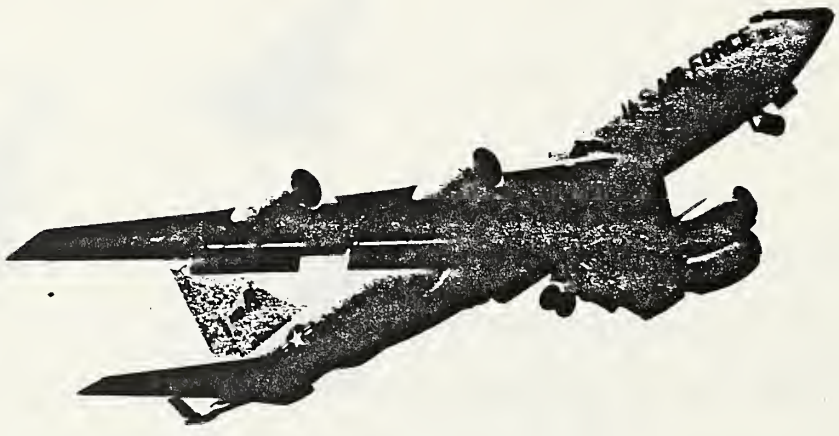
Although the US Air Force had yet to take any decision on the number of aircraft to be re-engined, CFM International officials believe it is reasonable to expect that something on the order of one half of the KC-135s, i.e., around 300, would ultimately be converted. The aircraft will be designated KC-135RE. With five engines per aircraft (one spare), the total order would involve the







Le premier Stratotanker KC 135 "R" a fait son roulage tout récemment. Ses quatre CFM 56 accroitront notablement ses performances (CFM International).



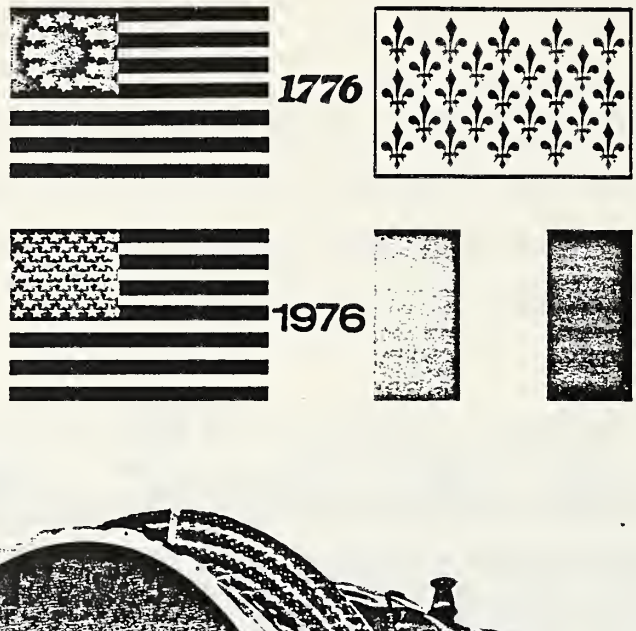
Le premier KC 135 R, remotorisé, sera livré à l'US Air Force en 1984 (Boeing MAC).

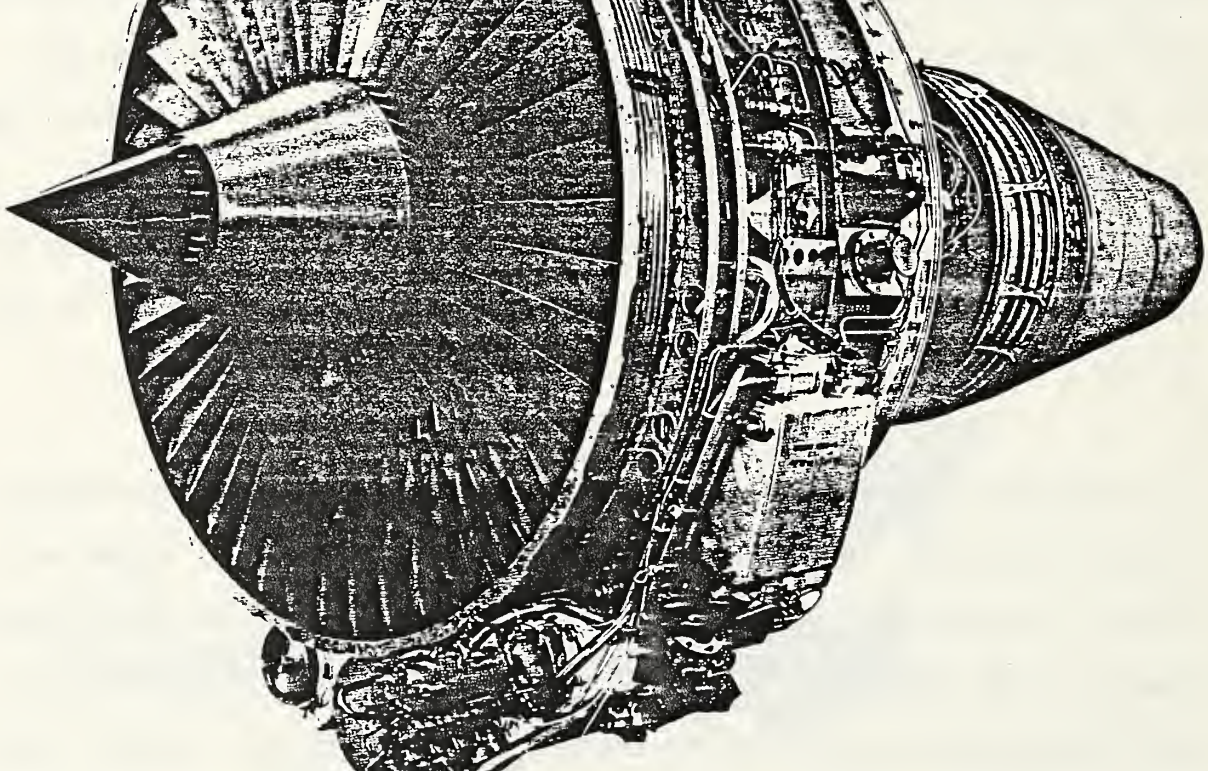
manufacture of some 1,500 engines, which—on the basis of Boeing's $10.9 million estimate for the complete re-engining of one 707—would represent a total cost of $3,500 million, according to Jean-Claude Malroux, President of CFM International, during a 1980 interview with Interavia.[7]

The USAF began to retrofit in 1982 the KC-135's, concurrent with flight-test as little risk had been anticipated. The retrofit program will serve to prolong the service life of the aircraft, the first of which was delivered to the USAF as long ago as 1957.

Re-engining will complement a life extension program started in 1975, in which the wings were reskinned. Other improvements under consideration for the KC-135 included winglets. These wingtip airfoils should save up to 45 million US gallons a year across the fleet by reducing aircraft drag some eight percent. It would take about four years to equip the KC-135s with winglets, by which time, it is estimated, the retrofit would have been paid for in fuel savings.[9]

The conditions under which the KC-135RE production work would be distributed between the two nations industries was initially up in the air. Under the terms of the General Electric/SNECMA agreement, the workload was to be shared equally by the two companies, though the initial agreement between the two manufacturers does provide for the engine to be manufactured entirely in one of the two countries if either of the two Governments concerned specifically requests this.[10] Although it has been expected back in 1980 that Congressional pressure might require the entire re-engining program be carried out in the U.S., this never occurred.





SNECMA-GE

MOTEUR CFM 56

SNECMA

cfm international s.a.

FILIALE COMMUNE DE SNECMA (FRANCE) ET DE GENERAL ELECTRIC (U.S.A.)

J.C HERGIER

As a reflection of the larger US market for the engine, CFM moved its head office from France to Cincinnati, Ohio in January 1980.

Commercially, the CFM-56 has also firmly established itself as an alternative powerplant for Boeing 707s and Douglas DC-8s. By early 1980 the program had come a long way since the September 1976 Interavia article which had referred to it as "an engine still looking for an aircraft".

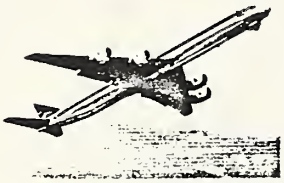
At the time the US Air Force decision was announced in mid-January, seven airlines had chosen the CFM-56 to update some of their DC-8 fleets - a total of 87 aircraft in all, involving some 500 engines.[11]

The conversion was being managed by Cammacorp, Los Angeles, Calif., which buys the engines from CFM International and is responsible for the modification design, certification and product support. McDonnell Douglas modifies the aircraft under contract to Cammacorp.

Boeing and CFMI provided the basic nacelle design for mounting the CFM-56 engine. Boeing supplied the necessary nacelle engineering data for McDonnell Douglas to design the new strut to interface with the 707/CFM-56 components and to support FAA certification.

The number six in Series 60 DC-8s is replaced by a seven to indicate CFM-56 conversion. The DC-8-71 is expected to produce a 21-25 percent fuel saving; on a DC-8-72 a 14-23 percent improvement is expected, and on a DC-8-73 a 14-20 percent saving. Entry into service began in late 1981. CFM also believes

CFM56. DEJA UN AN!



Après un an d'exploitation commerciale représentant plus de 100.000 heures de vol, le CFM56 a vraiment quelque chose à fêter.
Le moteur CFM56 s'est révélé supérieur aux autres moteurs débutants lancés depuis dix ans. Pendant sa première année d'exploitation, il n'y a eu pratiquement aucun retard dû au moteur sur 1.300 décollages. Les révisions non prévues sont tombées de 33 à 15 au cours de cette année.
C'est bien la preuve que le CFM56 se bonifie en prenant de l'âge.
Et qu'il grandit en sagesse.

Les DC-8 remotorisés sont beaucoup moins bruyants et moins gourmands, la consommation diminuant de plus de 20%.
Le CFM56 leur a donné une nouvelle jeunesse et une nouvelle force. Pour de nombreux pilotes, le DC-8/CFM56 c'est du gâteau.
Puissance, fiabilité, économie, le CFM56 tient la dragée haute à tous les autres moteurs.
Joyeux anniversaire.



cfm international
FILIALE COMMUNE DE SNECMA FRANCE ET DE GENERAL ELECTRIC U.S.A.



that high take-off weight DC-8-50s have potential for re-engining. Cost of re-engining a DC-8 is put at roughly $9 million (1978 prices).[12]

Taking one of the seven airlines as an example, Transamerica Airlines announced in December 1979 that it would re-engine its seven DC-8-63CF aircraft with General Electric/SNECMA CFM-56 turbofans at a cost of about $75 million. The airline's president said replacing the planes' JT3D engines with CFM56s would increase their useful economic lives by at least 10 years. Their range with a full payload would be increased from about 4100 to about 4650 nautical miles, their noise levels would be reduced by about 70%, and the airline would save about seven million gallons of fuel per year. The aircraft also would be able to use shorter runways, significantly increasing the number of airports at which they can operate.[13]

CFM-56 was certificated in November, 1979 and made its first flight on a Boeing 707 on November 27, 1979. A price of $10.9 million, including the engines and related changes to the wing structure and hydraulic, electrical and instrumentation systems, was being quoted for re-engining of 707-320 aircraft. About 500 of these were in service and Boeing believed the 707-700 would be attractive to carriers with long, thin routes. It could carry 160 passengers 5250 nautical miles, a 10% range increase over the JT3D powered 707, with a fuel consumption reduction of 14-18%.[14]

CFM-56 was also being proposed at that time for Airbus Industrie's four-engined TA11, Fokker's F.29, the McDonnell Douglas DC-9 Super 80 and a Boeing 737 derivative.

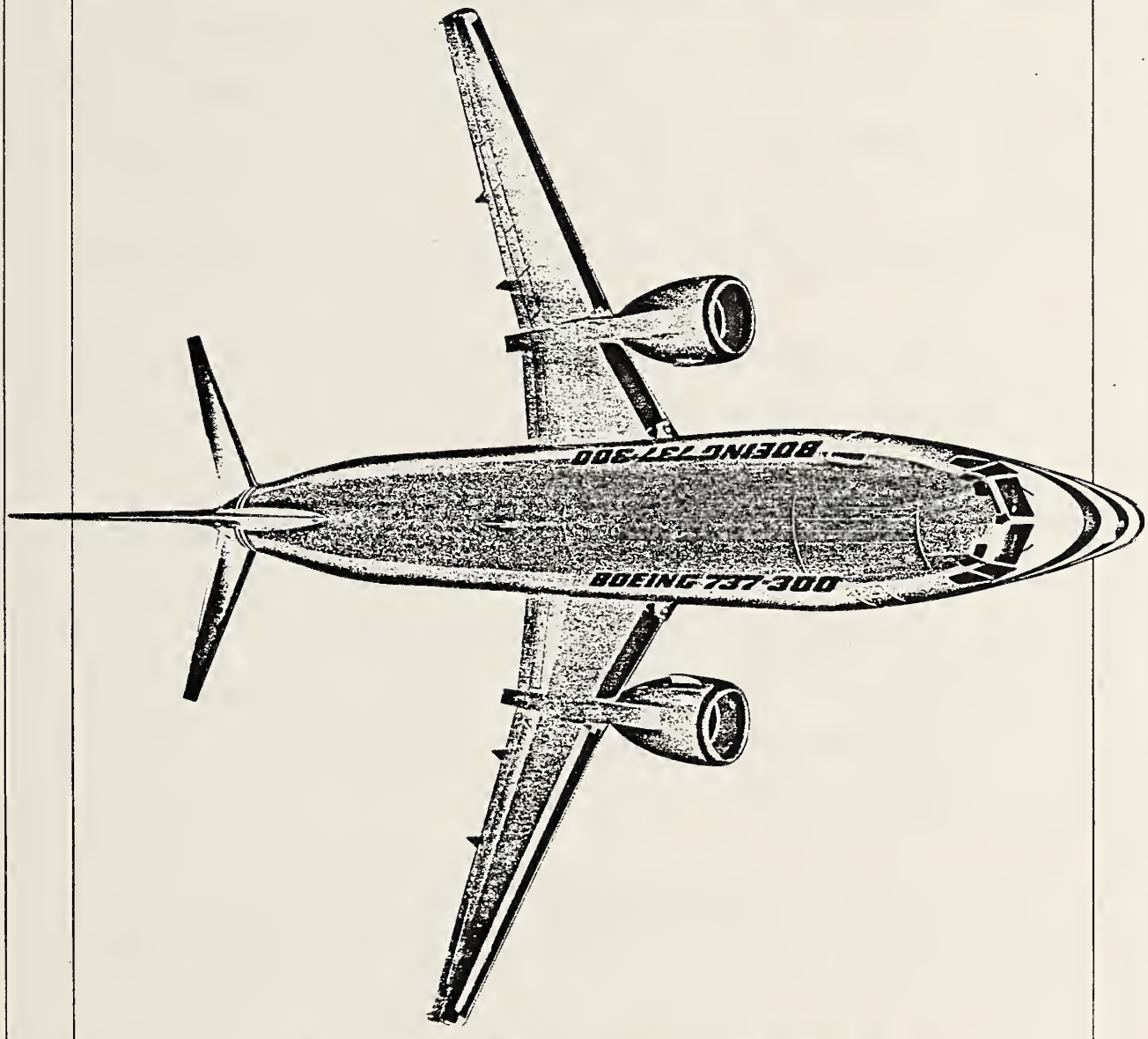
In December, 1980 came another major milestone for the new engine, but back on the military side of the market. France agreed to share 10 percent of the cost of the on-going USAF development engineering program to integrate the engine with KC-135's.

Disclosure of the intended Memorandum of Understanding (MOU) came in mid-December in a letter to Congress from Army Lt. Gen. Ernest Graves, director of the Defense Security Assistance Agency (DSAA). The joint project was to go into effect unless rejected by the relevant congressional committees by January 10— which it was not.[15]

Under the MOU, France agreed to pay $28.5 million of the common development engineering and non-recurring production costs (in FY 1980 U.S. dollars), while the U.S. paid $256.5 million. The French share was a fixed-price contribution in then-year U.S. dollars not subject to adjustment for inflation, changes in the numbers of aircraft eventually engineered, or any potential cost growths within the scope of the agreed program.[16]

The agreement covered all common development engineering and non-recurring production costs for the integration of the CFM56 engine. Any development engineering or non-recurring production costs unique to one nation's aircraft were to be borne by that nation. Once this R&D program had been completed, France planned to re-engine its entire fleet of eleven C-135 tanker aircraft. The estimated cost for this effort was $220 million (FY '80 U.S. dollars). Exact cost would depend upon where the French aircraft engines fell in the production line.[17]

FLY THE LEADER.



The world's best-seller has a four-year head start on everybody else.

The Boeing 737-300 is now in commercial service. It's just the start of Boeing's commitment to give the airline industry the right technology at the right time in the short- to medium-range market. Now that the 737-300 is off the ground, we're already at work on new ideas that'll put Boeing even further ahead. It will be late in 1988 before any competitor gets off the ground with passengers on board.

Sixteen customers have ordered 163 Boeing 737-300 jetliners.

BOEING
Getting people together.

In 1983 the CFM-56 was selected for two newer Boeing military systems utilizing the 707/C-135 family of air vehicles:

- The USN fleet of 15 E-6 aircraft for communication with submerged ballistic missile submarines.

- The Royal Saudi Air Force fleet of five E-3A's and eight KE-3A tankers.

Unlike the KC-135R retrofit program, the USN E-6, the Saudi E-3A and Saudi tanker programs all incorporated the CFM-56 in-line.

Meanwhile momentum had picked up in the commercial market with approximately 100 DC-8's being retrofitted with the CFM-56 and Boeing's selection of the engine for its advanced avionics/stretched version of the 737, the -300. Orders for fifty 707-300's had been placed by November 1983. Derivatives of the CFM-56 were also under consideration for the Airbus A320 and a possible -400 version of the Boeing 737.

By the end of 1983, the program had clearly become a major success story and France had finally penetrated the air transport side of the world jet engine market.

As of late 1983 this monument to Franco-American industrial teaming was apparently on the verge of another success with the probable belated selection by the French Air Force of the Boeing E-3A AWACS powered by CFM-56's to fill the nation's still open Airborne Early Warning requirement.

Chapter 11

MODE #6 BI-LATERAL OFFSETS

The bi-lateral offset Mode of industrial collaboration cropped up around 1959 on a low-level between the U.S. and two of its NATO allies, Canada and the Federal Republic of Germany (FRG). The diffuse set of Canadian offset arrangements originated within the framework of a series of unique government-to-government agreements over the years 1941 through 1963. Following a 1958 Canadian government decision to no longer unilaterally develop major weapon systems for its armed forces, Canada began to push more agressively for contracts to offset their orders for U.S. equipment, when license production was not feasible. This 1958 decision ultimately culminated in the U.S.-Canada Development Sharing Program signed in 1963. The FRG, for its part, starting 1959, was required to offset the costs of stationing U.S. troops in Central Europe through the purchase of U.S. weapon systems. The intensity of its use increased in the 1961-2 period with the U.S. Gold flow related, weapons sales offensive. This occurred within the context of a readjustment of transatlantic relationships following the economic recovery of Western Europe and the drastic phasing down of the Military Assistance Program (MAP). As the Germans had increasing difficulty digesting the weapons being forced upon them, later in the 60's, more purely financial offsets had to be introduced.[1]

The British had similar but looser arrangements with the FRG. The third NATO power, France, followed a different tact, however. This tact was influenced by the lower stature of the French aircraft/defense industry at this time, the

explicit policy of fostering Franco-German reconciliation, as well as the reparationist overtones of the Anglo-Saxon approach. France instead utilized its leverage to bring the Germans in as a junior, and eventually co-equal partner, to jointly rebuild their aircraft/defense industries through a wide range of collaborative projects. Starting with license production in the FRG of the Noratlas transport in the mid-50's (Mode #1 of industrial collaboration, see chapter 6), this rapidly expanded to include most of the early joint development projects (Mode #3) such as the Transall C-160 cargo aircraft (replacement for the Noratlas) the Atlantic maritime patrol aircraft, and the first Franco-German tank project (AMX-30/Leopard I) in the late 50's, the Euromissile family of tactical missiles in the mid-60's and the Alpha Jet in 1970. All these Franco-German joint development projects are treated in Chapter 8. This Franco-German teaming ultimately attained its crowning success with Airbus Industrie in the late 1970's.

Consequently France was not to enter the picture, nor the FRG for that matter, for Mode #6 on the selling end until fully re-established in the late 60's. Then in the 1967-70 period, the utilization of industrial offset agreements virtually exploded. The Germans with the Leopard I tank and the French with the Mirage III/V fighters used this technique to sustain their efforts to reassert themselves in the face of two decades of U.S. armament domination. The U.S. also resorted to various arrangements with the FRG and the UK in the 1967-68 time frame to assist the governments in their F-4 Phantom purchases and several other major aircraft procurements. Since 1975 the U.S. government and industry has entered into various bi-lateral offset arrangements for such

systems as the F-5 to Switzerland, the AWACS with the FRG, CH-47 to the U.K. and Spain, the Improved Hawk to Belgium and the Canadian purchases of the CP-140 and CF-18.[2] These sales related offset arrangements involved a mix covering the following range of sub-categories, all of which are borne out in one or more of the projects treated in this chapter.

(a) financial, political, or industrial;

(b) military or non-military hardware;

(c) government or industry provided (and if government provided whether its by the buying or selling government);

(d) external or internal to the system being purchased;

(e) internal or external to that quantity of the system purchased by the customer;

(f) sole or second source subcontracting;

(g) explicit or implicitly linked (the latter often being the case of U.S. government because of the difficulty of reconciling such necessary bargaining with U.S. competitive selection policies);

(h) reciprocal direct sales (a system for a system);

(i) the level of technology involved and the direction of its flow, and whether it is being transferred as intellectual property rights (i.e., know-how and data), or through hardware;

(j) the party providing the offset actually acquiring the goods or promoting their purchase by a third party.

Mode #7 is basically an expansion of this Mode of industrial collaboration from a bi-lateral to a transatlantic multi-lateral basis. The three major projects in this Mode, HELIP (the NATO-Europe Improved Hawk project), F-16 the Multinational Fighter, and NATO AWACS are all treated in the next chapter.

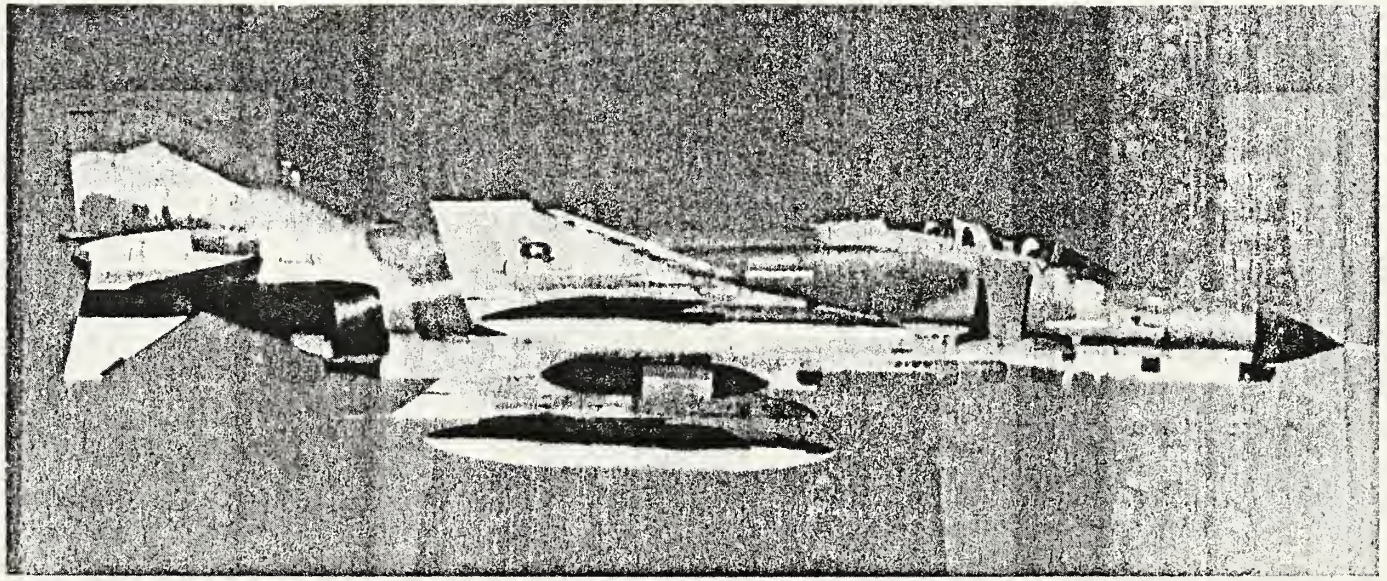
A. OFFSETS FOR BRITAIN'S F-4 AND F-111K ORDERS, 1965-1968

When Britain's Labor party came back to power in 1964, after 13 years of Conservative rule, they were faced with the prospect of having to cut-back on the considerably over extended British budget. A series of military program cancellations followed during 1964 and 1965 that were expected to bring quick disaster to the British aerospace industry. This did not happen, however.

Following this series of cancellations, the Labor Government opted for a less ambitious, but more realistic, approach to procuring the equipment needed by the armed forces while still sustaining its national defense industries.

In order to provide for a more rational basis for aircraft development, the Labor government decided to implement the recommendations of the Plowden Committee. The Plowden Committee, formed by the Labor Party after the elections to study the aircraft industry, had recommended the setting up of joint ventures with European partners as the only realistic route to maintain the national aerospace industry. Consequently, instead of the prior approach of taking advantage of its across-the-board capabilities to go it alone in the development or at least production of virtually all its needs, the new strategy would involve two additional supporting pillars:

(a) for use over the short term, direct purchases from the U.S. to fill immediate needs, reciprocated by an opening up of the U.S. market, and;



Small pod on centerline of USAF/McDonnell Douglas F-4 aircraft contains antennas and electronic components used to relay video and command signals between the aircraft and glide bomb weapons. The AN/AXQ-14 data link system was developed by Hughes Aircraft Co.

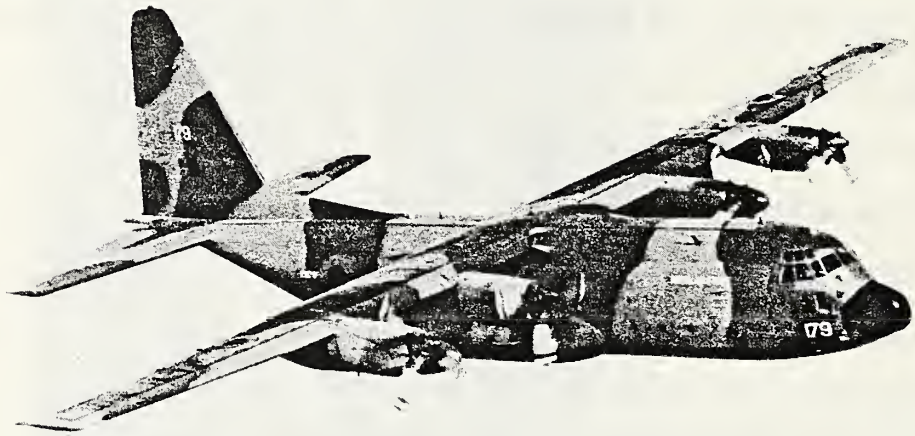
(b) what was to be a longer term solution, an alliance with France for the development of new systems.

The latter option involved the Jaguar/AFVG fighter package, plus the Puma/Gazelle/Lynx helicopter package, which are treated in Chapter 13 (Mode #8), and led several years later to a further diversification of its choice of partners to other continental nations as well, treated in Chapter 8 (Mode #3, e.g., MRCA and FH-70). Here we'll treat briefly the UK-U.S. procurement arrangements, as it was the pillar falling within Mode #6 of industrial collaboration.

During the 1965 to 1967 time frame the United Kingdom contracted for some 170 McDonnell F-4K and F-4M Phantoms, 66 Lockheed C-130 Hercules transports, and 50 General Dynamics F-111K variable-sweepwing aircraft to fill immediate requirements of the British Armed Forces. Such an enormous order for foreign aircraft was not something that the British Government could place lightly, in view of the country's recurrent, acute balance of payments problems and the importance of the British aerospace industry vis-a-vis employment, BOP, and technology. The budgetary savings achieved by cancelling the previous programs - especially the TSR-2 for which the F-111K was to be the replacement - would make little sense if they were replaced by a large budgetary and foreign exchange cost as well as massive industrial dislocation.

The arrangements adopted to minimize the disruptive effects of these procurements included a mix of British Government provided internal offsets, and U.S. Government provided external offsets. The internal offsets involved a modifica-

The HERCULES is a rugged aircraft primarily intended for tactical operations from short unprepared airstrips. If required, however, it is also capable of mounting long-range strategic lifts. Versatility is the keynote of the Hercules which may be operated in the troop-carrying, paratrooping, supply dropping or aeromedical roles. Photo: British MOD



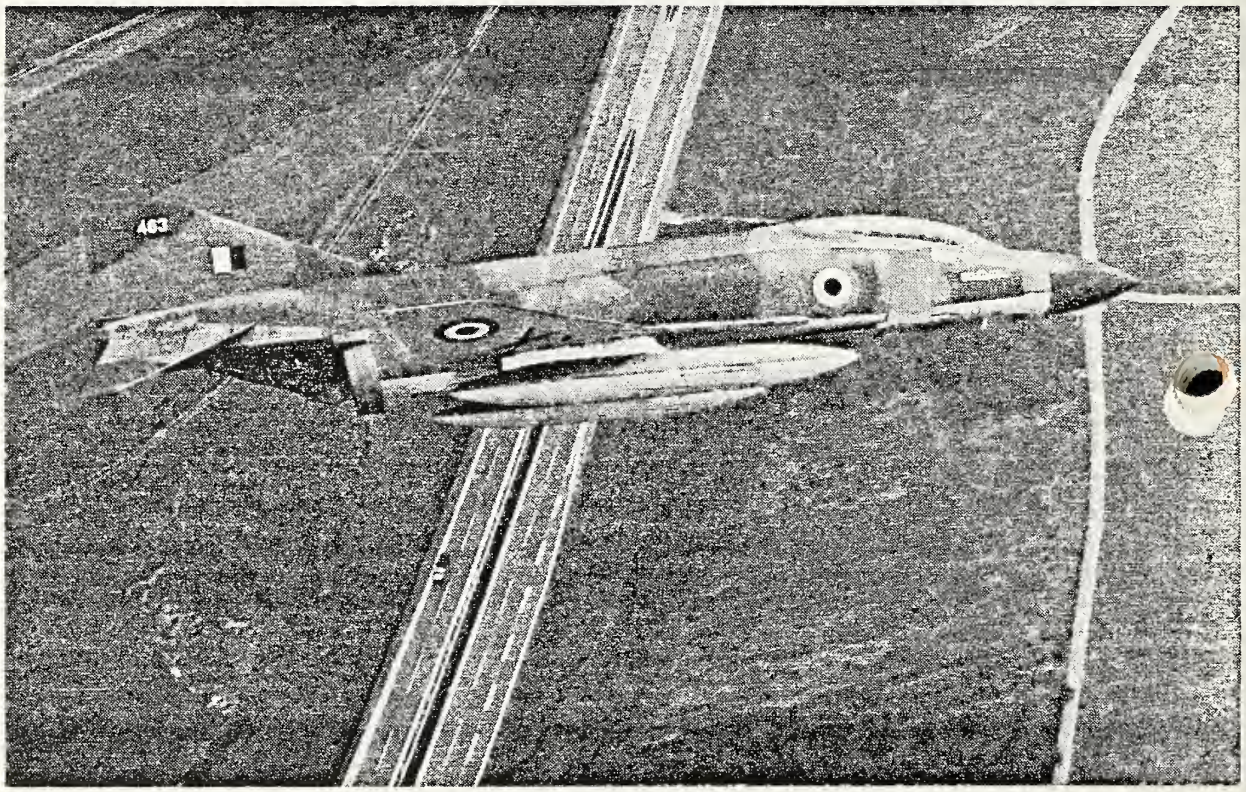
tion of the 3 U.S. aircraft so as to incorporate various percentages of British equipment. This was further complimented by a complex set of external offsets sales agreement with the U.S. for the F-111K. These were based on the removal of the Buy American barriers for British firms competing in the U.S. military market for contracts totaling up to a certain fixed level, plus the inclusion in additional 3rd country sales packages, both serving to help cover the dollar expenditures involved in the British buys.

No formal external offset was obtained for the British purchase of the C-130 or the F-4. The 66 Lockheed C-130 Hercules ordered for the RAF Transport Command, were purchased at almost exactly the same price as paid by the U.S.A.F., since only a minimal amount of British equipment was included. The reverse was true for the 170 F-4K and F-4M's ordered by the British Government.[3]

1. The British F-4 Phantom

It was originally decided to re-engine the Phantom with the Rolls-Royce Spey 25 bypass engine when the Royal Navy asserted that the Spey would be necessary to allow the Phantom to operate from existing carriers, mainly the Ark Royal.[4] When this became an urgent operational requirement, in February, 1964, development cost of the Naval version of the Spey, was estimated at $70 million. By June, 1964, when it was necessary to decide definitely whether to proceed with the project, the cost was provisionally reassessed at somewhere between $85.2 million and $109.2 million. However, the ministry had still not received a detailed specification or a costed technical program for the Spey engine. In

RAF Germany: F-4 Phantom Photo: Ministry of Defence, United Kingdom



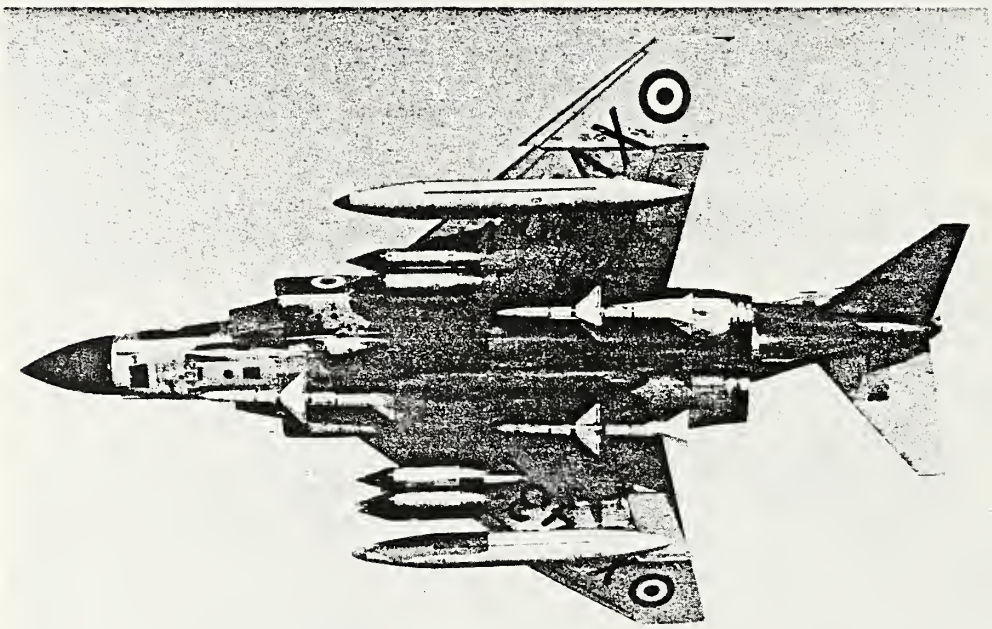
Source: NATO's Fifteen Nations

fact, a costed technical program was not received from Rolls-Royce until shortly after the decision had been made to purchase a version of the Phantom for the RAF in February, 1965. This costed technical program showed that the estimated cost of developing the Spey engine had more than doubled, and that the estimated production cost had substantially increased as well since June, 1964.[5]

It had finally been determined by May, 1965, that the total cost of developing the Spey engine, plus modifying the USN/McDonnell F-4 Phantom airframe to take the engine and British avionics, had risen to between $224 million and $252 million for both versions. Shortly, thereafter, the Royal Navy and the RAF reviewed the program and, in light of the unexpectedly high development costs, told the government that they would be prepared to accept the Phantom with an improved version of the General Electric J79, one which would allow operations from the Ark Royal. In spite of this, the decision was ultimately made to stay with the Spey.

In January 1968, with the announcement of the F-111K cancellation and other program cut backs in line with the British decision to abdicate its role as a world power and phase its defense commitments into a regional, NATO centered one, it was also announced that the order for 170 Phantoms was still good. At one point 50 of the 170 Phantoms had been earmarked for cancellation, in view of Prime Minister Wilson's decision to phase out the three British carriers when the East of the Suez withdrawal would be completed in 1971. The initial cabinet thinking was that the cancellation of 50 Phantoms would save the F-111K order, or at least most of it. However, in consideration

RAF Phantom carrying SPARROW missiles. Marconi Space and Defence Systems has developed the XJ421 variant of this missile. Photo by courtesy of Marconi Space and Defence Systems Ltd.



of the fact that the Phantoms were so far down the pipeline, and that it would have cost as much to cancel them as to take delivery, there was no Phantom order cut. The same reasoning applied to maintaining the order for 66 Lockheed Hercules as well.

The Ministry of Defense declined to give a unit price for the 170 Phantoms on order at the time of the January 1968 budget cut, although it did indicate that a few on the end of the order might eventually be cancelled. A defense offical stated simply that "we won't give the price, but we are paying more than the U.S. because we are pushing so much British equipment into them. This is a very sore point with me."[6]

What was known was that the Phantom had been Anglicized by about 46% of the total unit cost, with the Rolls-Royce Spey bypass engine as the major portion. The decision to Anglicize the airplane had called for a number of basic but costly design changes. In addition, there had been expensive delays due to problems with the Spey after burning system, and with the matching of the Westinghouse radar with the Ferranti navigation-attack package.[7]

An assistant secretary of the Ministry of Technology (the procurement authority for the British armed services at this time) finally informed the All-Party Parliamentary Committee of Public Accounts in August 1968, that the unit cost of the Phantom had doubled from $2.4 to $4.8 million, because of the decision to re-engine it with Spey engines. After taking into consideration the Navy and RAF's preference for an off-the-shelf purchase of the Phantomusing the

G.E. J79 powerplant, another assistant secretary at the Ministry of Technology told the committee that the decision to continue with the Spey was made on primarily industrial grounds.

In addition to the general industrial considerations, Ministry of Technology officials justified the decision on the grounds that the Spey had later been selected for the U.S.N./Ling-Temco-Vought A-7A Corsair. The Spey also allowed the Navy and RAF Phantoms an increased combat air patrol capability over the improved J79. In conclusion, in its report on the British Phantom cost increase, the Parliamentary Committee of Public Accounts noted: "We have no wish to question the decision to continue with the Spey-engined Phantom in spite of the large increase in unit cost, but regret that the earlier decisions, and in particular those made in 1965 to purchase the UK versions, should have had to be made on the basis of totally unreliable estimates and before the costed technical program for the engine was received."[8]

"The purchases of the Phantom aircraft, contrasted with the purchases of Lockheed Hercules aircraft, demonstrate that when off-the-shelf purchases are made, the benefit of reduced cost arising from long production lines can be totally lost if the standard version is substantially modified."[9]

The problem of the degree to which one modifies the configuration of a foreign system to meet peculiar national military and industrial requirements surfaces most often in license production programs (Modes #1, #2, and #4), and especially those where the U.S. is on the licensee end, i.e., Mode #4. The most recent

and visible case involves the production of the U.S. Roland version of the Franco-German Roland II all-weather short-range air defense missile system by Boeing and Hughes for the U.S. Army.

2. F-111K Order

The cancellation of the TSR-2 aircraft was announced by the Chancellor of the Exchequer, Mr. Callaghan, on April 6, 1965. Up till that time the TSR-2 had been regarded as the lynch-pen of the RAF in the 1970's. For the U.S. this opened up the prospect of being able to capture the British advanced military aircraft market with the USAF/General Dynamics F-111 vairable-sweepwing aircraft, a plane just then coming into production. The British Government was promptly granted an option to purchase the F-111, exercisable up to March 1, 1966. Given the size of the deal a substantial 'offset' became critical for the purchase, expected to be worth about $1 billion.[10]

The DoD ultimately agreed to a total offset figure of $725 million for the F-111 purchase and in 1967, after two years of negotiations Britain committed to a buy of 50 F-111K fighter bombers. The sale price of approximately one billion dollars was to be paid over a twelve-year period with the first delivery guaranteed by 1970.

The offset agreement contained two elements. First, the DoD agreed to waive the 50% price handicap for foreign firms, applicable under the Buy American Act, and thereby allow British firms to compete on even terms with American companies for $325 million worth of American defense contracts through 1977.

Second, the DoD agreed to join with Britain in securing $400 milion worth of arms sales to third countries. Although, the total offset figure of $725 represented about 75% of the aircraft's cost, the British were well aware of the difficulty of actually securing this amount - these figures being ceilings only, involving no guarantee of the final amount.[11]

While the negotiations with the British over their purchase of the F-111 slowly progressed, what was needed was a positive indication that a substantial proportion of the offset would be obtained. Accordingly, the concurrent U.S. negotiations with Saudi Arabia assumed a new significance. Although, Mr. Henry J. Kuss, Jr. (who was head of the International Logistics Negotiations (ILN) section of the DSAA) and British Defense Minister Denis Healey differ in their descriptions of the events that led up to the award of the major part of the Saudi contract to British industry, Healey's version being the more specific of the two (besides having nothing to hide), seems the more credible. The DoD apparently allowed the British to include the Raytheon Hawk surface-to-air missile in their package with the Lightning supersonic fighter. Moreover, as Mr. Healey stated, the Americans "undertook to stand aside" and allowed British industry to move up from a position of a non-starter and beat out the Lockheed F-104 and Northrop F-5. Kuss denied any such complicity of the DoD. Healey was further quoted as saying "we could not have made the offer, never mind won the contract, without American co-operation." Hence, at the time when Britain agreed to the purchase of the F-111K's, the prospective package deal with Saudi Arabia was specifically included in the F-111K offset arrangement. Even though the Lighting-Hawk package deal had not yet been finalized, it did considerably facilitate the British decision to buy the F-111K.[12]

Britain eventually received some $275 million for her part of the Saudi package: the Lightning fighters; the Jet Provost trainers; radar installations; and communications equipment. Britain received another $20 million for Thunderbird surface to air missiles to fill in as an interim air defense system pending delivery of the Hawk systems.

The outcome of this U.S.-UK arrangement resulting in the Saudi's obtaining of the Lightning in lieu of the F-5 or F-104, engendered further controversy, as it was militarily highly questionable. The Lightning was designed as a high performance interceptor for defending Britain's small air-space of some 89,000 sq. miles. For Saudi Arabia which is some 9 times larger (800,000 sq. miles in extent), it is open to doubt, whether Britain's U.S. supported package deal represented the best choice of weapons for Saudi Arabia.[13]

Another inter-ministerial understanding did not work out quite as well, this one being after the British buy. Part of the offset agreement included an understanding that the U.S. would allow the British to tender on equal terms with American Companies for 16 wooden-hulled minesweepers worth approximately $80 million. But in September 1967, John W. Byrnes, Republican Congressmen from the shipbuilding district in Wisconsin whose bidder was directly threatened, introduced an amendment to a defense appropriations bill, proposing that all U.S. naval vessels be built in U.S. yards. The amendment was eventually passed into law.[14]

As was pointed out in a number of British newspapers, with some bitterness, Britain's obligation to buy the F-111K's was subject to a binding contract,

while the U.S. obligation to buy minesweepers rested simply on a series of inter-ministerial understandings. A London Times editorial stated "the spirit of the offset agreement has been broken in Washington to an extent that must jeopardize British confidence in the future of artificial arrangements of this kind."[15] Yet, it was not Washington, but London, that would soon pull the rug out from under the arrangement.

After the November 1967 devaluation of the pound the British Government was forced into a series of public spending cuts so as to reinforce the credibility of the prior gesture. Included in this series of cuts were the National Health Service, school programs, public housing, and the order for 50 F-111K's. This cancellation of the F-111K orders involved such other contributing factors as the decision to retreat from east of the Suez which lessened the need for the airplane, while the planes' desirability also decreased due to performance problems and the cost having more than doubled.[16]

The 50 F-111K's were to be the core of the recently formed RAF Strike Command and consequently this Command would no longer have deep-strike capability, in view of the age of the Canberras and V-bombers which the F-111K's were supposed to replace.[17]

Prime Minister Wilson claimed that cancelling the F-111K would save the British Government about $960 million over the next 10 years, $700 million of which would be in dollar costs.[18]

This left the situation unclear though, with regards to the complex offset sales agreement with the U.S. which was meant to cover the dollar expenditure of British buys in the U.S. which amounted to an offset commitment of $825 at the time of cancellation (the DoD had recently increased its offset commitment by another $100 million as an additional disincentive to the pending cancellation). Though it was expected that the approximate total of $460 million in the existing offset sales already made over the two years that the offset agreement had been in force were still good, it appeared that as far as future offset sales were concerned that the agreement was dead. It was generally considered at the time (and correctly so as it turned out) that the existing contracts already in the pipeline would survive since the U.S. would have had to pay cancellation charges to British vendors, and programs would have to have been delayed for a new round of competition for equipment to replace the cancelled items.

While shocked by the British decision to completely cancel the F-111K, the Johnson Administration was naturally reluctant to make any overt moves of recrimination or retaliation.[19] In any case, Britain still had substantial commitments in the U.S. - particularly for the F-4 Phantom and C-130 Hercules orders - and as such offsetting considerations still applied to some extent, although not in line with the F-111K agreement.[20]

One positive aspect of this F-111K offset sales agreement was the significant contribution it made to the remarkable recovery of the British aerospace industry following 1964-65 series of cancellations. Although, eventually aborted, during

British Offset Contracts in U. S.

Equipment	Approximate value (millions of dollars)
U.S. Air Force	
Handley Page Jetstream aircraft	5.75
U.S. Navy	
Radio frequency equipment	0.12
Shuttle assemblies	0.14
Two survey ships	16.73
Three salvage tugs	24.09
Piston assemblies	0.04
Arrester cables	0.02
Boiler tubes	0.01
U.S. Army	
Dracone oil transporters	0.10
Assault trackway	0.47
Tobias battlefield intruder alarm system	0.01
U.S. Defense Supply Agency	
Barbed wire	1.30
Steel pipes and tubes	0.20
Construction equipment (posts, bolts)	1.30
U.S. industrial prime contractors	
Rolls-Royce Spey engines	82.0
Elliott Automation head-up displays	41.3
Elliott crosswind steering computers (C-5A)	1.47
Machine tools	2.73
Air data computers	2.0
Energy management computers	0.90
Artificial feel simulators	0.40
Approximate total direct sales	180.98
British share in Saudi Arabia defense package	280.0
Total approximate offset contracts	460.98

Source: Aviation Week and Space Technology

its existence, the offset agreement had..."spurred such British companies as Elliot-Automation and Handley Page into sharp, successful forays into the American market..."[21]

As one senior British executive put it, "since the offset, we've set up the machinery to keep up the sales pressure. But most of all we broke out of the island complex and took our products into the toughest market of all and won an equal terms."[22] Hence, the offset agreements were instrumental in establishing a foothold for British avionics firms in the U.S. military market, a foothold from which the British firms have since succeeded in expanding into the U.S. civil market.

On the negative side, in addition to the inevitable unit cost increase for the U.S. F-111's resulting from the British cancellation there is the all too evident fragility of such complex arrangements. Not only are they built upon ministerial understandings and, therefore, vulnerable to unilateral decisions of the sovereign authorities in either nation, but they are extremely difficult to implement without resulting in considerable ill will.

B. THE FRG F-4 OFFSET, 1968-1974

1. The Agreement

On November 7, 1968 the U.S. Assistant Secretary of Defense for International Security Assistance (ISA) and the State Secretary of the German Federal Ministry of Defense (FMOD) signed a multi-year (1968-1975) cooperative logistics agreement for the procurement of RF-4 aircraft by the FRG. The agreement's official title was "US/FRG Cooperative Logistics Agreement in Connection with RF-4 Procurement." This agreement involved a pledge undertaken by the U.S. Government to use its 'best efforts' with McDonnell-Douglas Corporation (MDC) and other U.S. contractors to place $125 million worth of contracts with German firms,[23] but specified that any contracts offered to German industry would also be offered to American firms, being awarded to the lowest bidder. The German aerospace industries could obtain these contracts by being either the low bidder, or simply through the German Government subsidizing the difference between the American and German bids, at its discretion.[24]

This industry offset was backed up as well by a U.S. Government guarantee to place up to $50 million in contracts to German industry to cover any industry short fall of the $125 million goal. Although the U.S. had agreed to allow German firms to bid on components for the F/RF-4 aircraft produced by McDonnell Douglas, the Germans apparently were rather sceptical of this offer. The vagueness of the term "best effort", and the stipulation that German subcontractors be price competitive with American firms that had been involved in

producing such component assemblies for some years, had made the Germans push for some sort of guarantee.[25] The U.S. finally consented to the $50 million back up guarantee which was to be Phase II of the arrangement. The consummation of the above agreement cleared the way for final approval by the Bundestag's budget committee for the procurement of 88 RF-4 aircraft plus supporting equipment and services.[26] In return for this pledge of the U.S. Government to make its best efforts to obtain U.S. industry compliance, Herr Schiffers of the FMOD, signed the LOA (DD form 1513) legally binding itself by contract for the purchase of 88 RF-4 aircraft two weeks later on November 21, 1968, for $415 million.

On October 31, 1968, in anticipation of the signing of the agreement, McDonnell-Douglas applied with the Office of Munition Control (OMC) of the U.S. Department of State for a license to export technical data to German Industry. The data was to include specifications and drawings necessary for preparation of bids on 23 different RF-4 structural components for 288 aircraft. The license was rushed through and approved on November 4.

2. Background

In January 1968 the Luftwaffe had made a fundamental decision for two wings of McDonnell Douglas RF-4E reconnaissance strike fighters to replace the 80 F-104G's lost in crashes since 1961. This Luftwaffe decision however, was faced by strong opposition from some elements of the Defense Ministry and the Bundestag, which were pushing instead for production of an advanced version of the F-104 for this mission, the RF-104G1.

It was understood that some form of German industrial participation would be necessary whichever choice prevailed, since such participation was essential to the viability of the German aerospace industry during an expected 1971-1973 production gap before production was to have begun on the replacement aircraft (one that was eventually to evolve into the MRCA Tornado). The advantage of the RF-104G1 option was that it could be produced, even in small numbers, with tooling already available. For the RF-4E several coproduction schemes were considered.[27] Complete fabrication in the FRG was briefly considered, but unless an unlikely total of 180 or more aircraft were ordered, this would not be feasible.[28] The proposal considered to be the most likely choice at the time was one in which German industry, probably Messerschmitt, would build such fuselage components as the aft section, outerwings, engine doors and canopies. In addition Man Turbo would build about 50% of the General Electric J79 engine (which it had built in the FRG for the F-104G program, the G.E. J79 being the engine for both the F-104 and the F-4).

This German work was expected to amount to around 25% of the total cost of the program, whether the final assembly was done in the FRG or the U.S.[29] In the end, however, the defense and finance ministries opted for an off-the-shelf buy of U.S. produced RF-4E in order to minimize costs.[30]

As is normal in such controversial decisions a number of conflicting interests had to be reconciled. The Luftwaffe wanted the RF-4E because it considered it the best available aircraft for the mission. The Luftwaffe did not consider the reconnaissance version of the F-104G acceptable because of its previous

performance record. On the other hand, the West German Aerospace industry undertook a considerable lobbying effort with the Bundestag and the Ministry of Defense in support of its view that reconnaissance version of the F-104G could fill the need. Industry's major argument in support of the F-104G variant (and therefore licensed production in the FRG) was that the RF-4E was a much more expensive aircraft, and one that would cut into the funds available for the MRCA, expected at that time to enter production in 1975. In addition, German industry and government opponents of an RF-4E buy, as well as large segments of public opinion, felt that the Phantom was being forced upon them by the U.S. The considerable resentment to U.S. pressures was symptomatic of the changing German attitudes with regards to NATO and defense generally, but also the promotion of its own technological base through greater indigenous aerospace work.[31]

Meanwhile, in addition with pressures from the U.S., the French government was also placing diplomatic presure on the German government toward selection of the Dassault Mirage 3R.

The replacement decision was to have been made in May 1968, but was delayed until the fall session of the Bundestag. The decision, one which was expected to face extended debate, had to be delayed as a result of the protracted debate over giving the government emergency powers in revolts.

In October 1968 three new factors surfaced that were to prove decisive in weakening the resistance to the off-the-shelf RF-4E buy. One was that the current

CDU Defense Minister Gerhard Schroeder was expected to be his party's candidate the following year for the Presidency of the FRG. Since Schroeder had backed the RF-4E buy throughout the long debate, the CDU members did not want to be in a position of opposing their leader.[32]

Another factor was a proposal made by Henry J. Kuss, Jr., the U.S. deputy assistant defense secretary for International Logistics Negotiations (ILN). Kuss offered the FRG a wide-ranging aerospace license and subcontracted production plan worth between $50 and $100 million on condition that the FRG order the RF-4E by December 1, 1968.

The basic points of the Kuss proposal were:

- "Buy American" act would be waived in considering bids by the German aerospace industry (and German components would enter the U.S. duty free).

- West German companies invited to make competitive bids will be given large enough orders to ensure competitive conditions.

- Any available excess tooling for the job in the U.S. will be offered at reasonable prices to the FRG.

- Technical data and manuals necessary to initiate production will be made available to West German industry for the cost of reproduction.

- U.S. State and Defense Departments will help in clearing export licenses required for bidding.[33]

The third factor was that of the U.S. resorting to one of its common techniques with the FRG, one that might more politely be called 'arm-twisting'. This involved the new, tougher demand made by the U.S. Defense Secretary that the FRG pay more to help offset troop-stationing costs, otherwise the U.S. would have to reduce its tactical air and troop strength in the FRG. The year 1968 also happened to be the year that Senator Mike Mansfield was spearheading a major drive in Congress to do just that.

3. The U.S.-FRG Troop Offset Agreements Covering 1968-1971

Originating back in 1959 as a mechanism for offsetting the large dollar drain caused by the stationing of U.S. troops in the FRG, these agreements continued through the 60's and up to the mid-70's before they were terminated. These annual or bi-annual agreements developed into a predominant feature of U.S. arms sales to Europe during this period. However, they gradually became an increasing irritant as the FRG equipment requirements became less pressing after the mid-60's. This was also accompanied by a resurgence of German nationalism. Here it is worth taking a look at those agreements covering the 1968-71 period to see how they were interrelated with the German F-4 buy, the cost of which involved basically two elements. Roughly 30% involved industrial offsets to the FRG, and the remaining 70% counted toward the dollar cost of troop stationing incurred by the U.S. government.

In July 1968, the German government agreed to offset 75% of the costs of stationing U.S. troops in the FRG during Fiscal 1969. Since the decision on the replacement aircraft for those F-104G's lost through crashes had slipped, and had not been made in May as planned, the RF-4E purchase was not to be included in the agreement.

The U.S. had asked for a full offset of $800 million, but accepted $100 million in purchases of unspecified military equipment, plus $500 million that the Bundesbank would take in medium-term U.S. Treasury bonds due in 10 or 12 years. The German government also undertook to persuade a German banking consortium to purchase an additional $100 million in bonds during the next fiscal year.[34]

As reported in Aviation Week & Space Technology, one observer in Germany termed the agreement "a bookkeeping ploy, designed for the U.S. election year." He said the $100 million in military purchases is not really an offset because the Germans probably would have bought that much anyway. He said the offset amounts to a loan from the German government which the U.S. will not carry on the books as a liability as it would a short-term loan.[35]

Another source acknowledged to Aviation Week & Space Technology that the Germans have "acute financial problems at home" which were not helped by the recent mild recession. Not only would it be a political liability for the FRG to buy too much from the U.S.—since German companies would object—but "they can't afford to buy anything just for offset and then have it sit and rust through lack of funds or personnel to operate it."[36]

An offset agreement for the British Army of the Rhine (BAOR) was also concluded. Of the $180 million in the total agreement, $50 million worth of British bonds were to be bought and the remainder would be accounted for in purchases of British goods by government or private organizations.

The other foreign countries maintaining military units in the FRG—Belgium, Canada, France, and the Netherlands—had not asked that their costs be offset through some such explicit arrangement.[37]

In July 1969, the U.S. government reached a two-year offset agreement with the FRG for $1.5 billion or 80% of the total U.S. balance-of-payments costs in connection with stationing of forces there, one covering the period July, 1969 to July, 1971.

In the agreement signed by the U.S. and the FRG covering the period July 1969-July 1971, the FRG agreed to buy $925 million worth of U.S. equipment. This was about 60% of the $1.52 billion to be offset in the two-year period. The remainder was to be accounted for by financial transactions. In addition, there was another $300 million held over from previous such agreements. Over the two year period, most purchases of U.S. military equipment were to involve some degree of co-production. Major projects included:

- McDonnell Douglas RF-4E, $300 million (excluding offset work);
- Sikorsky CH-53, $115 million (treated in Chapter 6);
- Bell UH-1D, $80 million (assembled by Dornier);

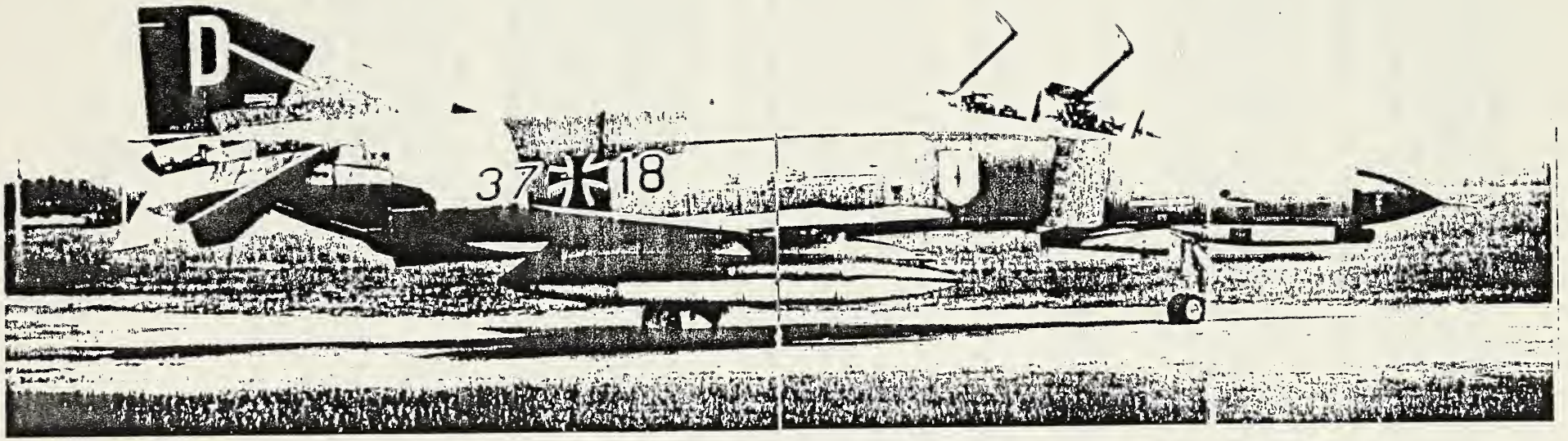
- North American OV-10Z target tow aircraft, $10 million, and;
- Luftwaffe pilot training in the U.S., $10 million.

These purchases and other, non-aerospace defense orders left about $400 million that had to be spent on U.S. military equipment over the 1969-71 period.

The German offsets for British military equipment were averaging about $50 million annually, and the commitment covering the 1969-71 period was settled with the purchase of 22 Westland SH-3 search and rescue helicopters.[38]

As for the financial part of this two-year agreement (40% of the total), the FRG pledged to buy $250 million worth of U.S. Treasury bonds with 10-year maturity at 3.5% interest. Past offset loans were made on a short-term basis at prevailing interest rates, an arrangement which reportedly caused considerable resentment in the U.S. government. In addition to agreeing to accept lower interest payments from the U.S., the Bonn government also agreed to apply $32.5 million of past interest credits to military purchases in the U.S.[39] The FRG was also to buy $118 million in Export-Import Bank and old Marshall Plan debts owed the U.S., and prepay $44 million of other German debts. A final move, under the agreement, was the establishment of a special fund of $150 million for German investment in the U.S. The investment fund would carry commercial interest rates in contrast to the arrangement on U.S. Treasury bonds.[40]

These favorable offset terms were again successful in relieving pressure on the Administration from Congress to reduce U.S. force commitments in Europe,



Germany's F-4s are scheduled for improvement

on the grounds of the U.S. balance-of-payments (BOP) problems. Sen. Charles H. Percy (R.-Ill.), who had recently attempted to win European support for a multi-lateral offset arrangement, called the new agreement "a major step toward creating a sounder financial basis for U.S. expenditures in the North Atlantic Treaty Organization." He said a multi-lateral approach was still desirable because it would eliminate what he called the "agonizing, disturbing and humiliating bilateral negotiations that endanger German-American relations."[41]

4. Fulfillment of the Offset

On November 11, 1968, the first bid packages were released by McDonnell Douglas involving wing flaps, rudders, main landing gear, canopies and windshields. On November 18, packages were released for outer wing panels and pylons. A final series of bids were released November 25 and involved engine access doors, empennages, horizontal tail surfaces, radomes and tail assemblies.[42]

The following June, 1969, two German aerospace companies, MBB and Dornier, won subcontracting awards for McDonnell Douglas F-4 fighters that were to be delivered to the U.S. Air Force and Navy, as well as the Luftwaffe. The Messerschmitt-Boelkow-Blohm group was to supply the aft fuselage, including the fin and tail cone, rudder, two engine access doors, ailerons, outer wings, inboard and outboard spoilers and main landing gear doors. Dornier was to furnish an engine access door and the center leading-edge flap. The bids that were submitted were reportedly lower than the cost of the items being produced in the U.S., due to substantial German government subsidies in the program.[43]

General Electric, meanwhile, told German engine companies that it was willing to contract work to them not only on the J79 that powers the F-4, but also on T64, CF6, and TF39 engines.

The first increment of airframe components had been for 100 ship sets and amounted to $20 million, and bids were submitted for options on an additional 200 ship sets. Orders for the additional 200 ship sets, however, were not to be forthcoming for several years because of a downturn in F-4 sales world-wide. This and other problems that arose in the interim are treated in the following section of this sub-chapter.

In November, 1972, the OSD (DSAA) granted authority to the Project Office to proceed with Phase II activity, that is, the back-up guarantee of the U.S. Government placing contracts with German industry up to the $50 million ceiling. The Project Office cited one specific potential contract by the USAF Europe for its F-4 aircraft with MBB for around $15 million. This possibility was put to rest, however, the following May when both the U.S. and the FRG agreed that there would most likely be no need for it. As such the DoD never had to supplement the industry-to-industry offset contracts with its own offsets.

On 8 May, 1974, the last U.S./FRG meeting was held to formally terminate the 1968 Agreement, the $125 million offset having been fulfilled. Additonally, all U.S. firms involved in the Agreement's implementation were advised that the special procedures for processing export lincenses, bid packges, and technical data were no longer in effect.[44]

The official total of offset contracts reached by the end of each Fiscal Year was:

Fiscal Year	Dollar Value
1970	7.7 M
1971	15.8 M
1972	76.4 M[45]
1973	120.3 M
1974	125.0 M

The German aerospace industry had in fact received about $136 million in creditable offset contracts by the termination date. But beyond this German industry had obtained several major licenses and proprietary manufacturing processes, the value of which was never counted toward the offset. In addition some $44.04 million in orders resulting from two of these licenses was never counted.[46]

5. Key Issues: the Berry/Peterson Study

The slow start in implementing the Agreement, by placing offset contracts with German industry became an issue of major concern in the German press and German politics. During the first several years following the signing of the contract, this led to strong criticism of the U.S. handling of the program from within the FRG. The bad publicity hurt U.S. credibility. The August 11, 1969 edition of Der Spiegel attacked the program for offering only crumbs (i.e., small quantities of low technology components) to German industry for bidding.

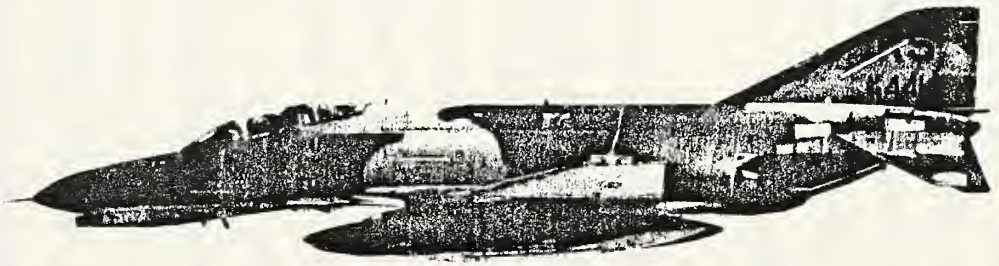
Furthermore, Der Spiegel claimed that the minor quantity of items offered for bidding, placed German industry in an uncompetitive position vis-a-vis U.S. firms; German industry only getting what little it did becuase of German Government subsidy. As this developed into a major political issue over the following month, during the closing days of the German elections that fall, Defense

Minister Schroeder had to forcefully deny these claims and others such as charges that German industry would receive only $25 million instead of $125 million.

The DoD reacted to the initial insufficiency of the contract awards to German industry, and the German sensitivities in this respect, by shifting its policy in the fall of 1969.[47] Up till then, the DoD had seen its role to be one of monitoring contract award status and minimal involvement in industry-to-industry interactions. The shift led to the DoD's assuming the role of an active coordinator and initiator of industrial activity.

A thesis by Arnold M. Berry and Edward A. Peterson entitled RF-4 Coproduction: The United States and the Federal Republic of Germany presented in January, 1975 to the Air Force Institute of Technology (AFIT) covered the history of the DoD's role in the project in considerable detail. The following paragraphs draw from this thesis in treating several major issues that arose during the program, as well as Berry and Peterson's conclusions and recommendations.

Berry and Peterson believed "that the only major problem in the coproduction effort stemmed from the lack of specific and objective guidelines in the Agreement. Although, there was some confusion over the meaning of "best efforts", it became relatively unimportant when compared to the administrative difficulties caused by the lack of detailed parameters and criteria to determine what type of coproduction contracts would be credited toward the $125 M offset."



F 4 Phantom II de l'USAF Europe, Ramstein AFB (Adj. E. Moreau).

The agreement did not specify that the $125 million in contracts had to be on F/RF-4 components but only that this was preferable. The types of contracts that would be creditable became a key political issue throughout the life of the agreement, the two governments having very differing views of the permissiveness that could be used in reaching the $125 million goal. The FMOD viewed this Agreement as restricting creditability to RF-4 and F-4 components, whereas the U.S. did not recognize this restriction. When the production rate of the F/RF-4 had slowed due to a lack of incoming orders, McDonnell Douglas found that it couldn't submit requests for quotations (RFQ) for F-4 components to the Bundesverband der Deutschen Luft-und Raumfahrt Industrie (BDLI)[48] in sufficiently large quantities for German industry to be competitive. It therefore offered DC-10 work instead, but the FMOD rejected these as not creditable. It also refused to allow G.E. offers relating to the modification of Luftwaffe F-104G engines. In addition the FMOD held that the value of contracts granted by the FMOD directly to German industry to provide equipment to McDonnell Douglas as German Government Furnished Equipment (GFE) were not creditable either, even though U.S. industry (with U.S. Government approval), i.e., General Electric and Litton, had granted the license which allowed these orders to take place under the assumption that they would count toward the offset. They did eventually compromise though, on this latter point, and accepted a percentage of such contracts (around 30%) as creditable. If there had been clear criteria for creditability such disagreements could have been avoided.[49]

Another weakness that Berry and Peterson found with the Agreement was that it was not balanced in its distribution of responsibilities. They found it to be biased in that it . . .

> did not require the German Government to do anything to make German industry even accept or attempt to be competitive with U.S. industry. The absence of any commitment by the German Government to also use its "best efforts" toward reaching the $125 million objective had the effect of increasing the United States' responsibility.[50]

As for the highly visible difficulties of the German contractors in competing effectively with U.S. firms, Berry and Peterson felt that this was not a major problem.

> The apparent inability was really caused by the difference in contract procedures between the two countries. Once, the German Government and the aerospace industries had the time between 1968 and 1971 to adjust their bidding procedures to be compatible with the U.S. subsidy program with U.S. defense contractors, Germany was able to effectively compete with U.S. firms.[51]

One must qualify this statement by Berry and Peterson however, by pointing out two other factors. One, the fact remains that, though this problem was worked out over time, the several years it took to do this resulted in a great deal of unfavorable publicity. Secondly, a major determinant that finally allowed a second bid package and the submittal to the BDLI of orders based on larger production quantities to be placed, was that the FRG ordered an additional 175 F-4's in 1971. Therefore, in addition to the bidding procedure/subsidy aspect of the competitivety problem, the additional F-4 order by the FRG was also a significant factor contributing to the breakup of the log jam.

The Foreign Military Sales Division, F/RF-4/Sparrow III Project Office, Naval Air Systems Command (NAVAIR) had been given the responsibility of coordinating and monitoring the implementation of the Agreement, thus becoming the focal point of all related information and actions. The principal issue that the authors were concerned with, concerning the Project Office, was whether it was at the correct level of governmental authority to effectively and efficiently

carry out its responsibilities. This is an issue that has continued to resurface in other joint production programs since (e.g., F-16, AWACS), and as such the following quote has continued to be relevant to such programs.

> From the standpoint of efficient and effective implementation of the coproduction project, the Project Office was not at the correct level of authority. The Project Office was not able to initiate procedures or make firm commitments without coordinating with agencies higher in the hierarchy. This upward coordination usually went as high as DSAA, but on some occasions, it was to the OASD/ISA and on several occasions to the Assistant Secretary himself. The delays required for the communication up and down the chain of command hampered the ability of the Project Office to function at full efficiency. The Project Office developed a viable and specific plan to implement the coproduction agreement, but the fact remains that the Project Office was not tendered the authority to make key decisions and commitments. The delegation of sufficient authority to the Project Office, or the shortening of the command channel by placing the Project Office directly under Director of Military Sales and Assistance within the OASD/ISA would have alleviated the problems associated with the lack of authority in the Project Office.[52]

One of the important side issues that developed out of this Agreement was the differing interpretations of F/RF-4 FMS management resonsibilities at the working level within the DoD. The Navy and Air Force were in disagreement as to who was responsible for the overall execution of the F-4 sales program. It was not until August, 1970, that the Deputy Assistant Secretary of Defense for Military Assistance and Sales issued a memorandum stating that the NAVAIR Project Office had the lead in the U.S./FRG Cooperative Logistics Agreement program.[53]

The final issue treated by Berry and Peterson was whether any policies and procedures were established during the Agreement's implementation that could be useful in the formulation of future joint production programs:

The definitive implementation plan developed by the NAVAIR Project Office was and is critical in the implementation of any international logistics program. The virtues of good planning need not be discussed because they should be obvious to any responsible modern day manager. The implementation plan for the Agreement provided visibility and confidence to U.S. and German industry that the U.S. Government was seriously committed to the fulfillment of the Agreement. Additionally, and most important, the plan exposed the channels of communication that provide coordination and information.

The identification and broad advertisement of the focal point in the form of a management office to implement the program was important. However, there must be more communication between the focal points of the two respective countries in the form of exchanging plans and status reports.

The format of the status reports written by the NAVAIR Project Office were excellent because they provided cumulative information so that anyone could quickly be brought up to date and become involved in the program. This would seem to be important to industrial firms because it would save them time and expedite their possible involvement in the program.[54]

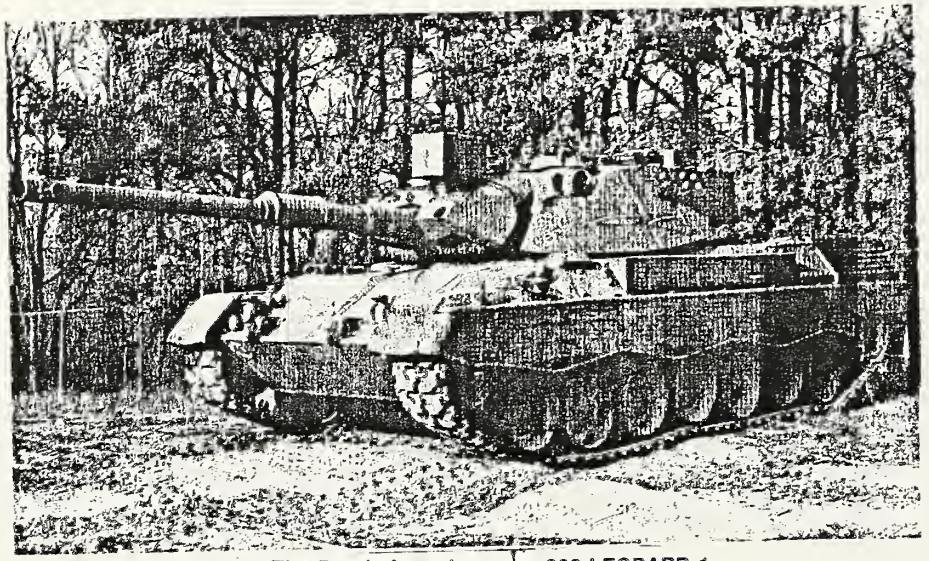
C. INTRA-EUROPEAN OFFSETS, 1967-70

During the same period (1967-70) that the DoD was getting its feet wet for the first time with regards to the rude world of offset agreements (i.e. the agreements accompanying the British F-111K order and the German F-4 Phantom buy) several of Europe's continental defense industries were beginning to make important in-roads into other Western European markets, an area previously dominated by the U.S.

This market penetration during the late 60's was greatly assisted by the offering of bi-lateral offset agreements to the purchasing nations. The previous two U.S. offset agreements had not been offered by the U.S. government simply as competitive inducements, but primarily as efforts to smooth the way politically and industrially for the purchasing allied government to fill a major military requirement. In neither case was there any serious foreign competition. On the other hand the European offsets of the same period covered in this sub-chapter, could be characterized more along the lines of a teaming of national governments and industries in attempting to break out the U.S. strangle hold on third country sales in selected product areas (e.g. tanks for the FRG and light fighter air-craft for France and Sweden).

1. The Belgian, Dutch and Norwegian Purchase of the Leopard Tank

In 1967 the FRG made her first major post-war penetration of the intensely competitive Western European arms market with the sales of the Leopard I tank



The Dutch Army has over 300 LEOPARD 1 MBTs

to Belguim.[55] The following year, the Netherlands and Norway also, both bought the Leopard. Each nation's selection of the Leopard, though not exclusively dominated by offset considerations, was in good part influenced by them. The FRG, with her strong foreign exchange position can be much more generous than either the U.S. or U.K. in this area. Both of these latter two are dependent on arms exports to bring in much needed foreign exchange. Another consideration relevant to Belgium and the Netherlands that goes beyond NATO, are their extremely tight economic and financial relationships with the FRG, displayed in, and further reinforced by, their continual participation in the Deutsche Mark centered European Snake from 1972 up through the creation of the European Monetary System (EMS) in early 1979, and the EMS since.

To Belgium, the Germans offered a mix of government provided military and non-military external offsets, while the German Leopard manufacturer, Kraus Maffei, subcontracted to Belgian industry for certain parts of the tank. Collectively the offset covered a full 100 percent of the purchase, or in other words there was no BOP effect over the long run. The total cost of the 334 Leopards purchased by Belgium came to some $91.4 million: with some $44.3 million being offset by German Government contracts to Belgian industries for munitions and electronic goods, and for the overhaul in Belgian factories of German armored vehicles; and with the remaining $47.1 million being offset by Leopard parts production in Belgium and by the import into the FRG of a variety of Belgian goods that would not have otherwise been imported. A similar 100% offset was also provided for a related tank order by the Belgian Government at the end of 1968 for 36 recovery tanks and 6 engineer tanks.[56]

The Dutch Government chose to offset the foreign exchange cost of its 415 Leopards ($112.8 million) by a fixed amount (as opposed to a percentage), one which would effectively offset around 90% of the purchase. The German Ministry of Defense agreed to make purchases of military goods in the Netherlands for one-half the total, $56.4 million, plus Kraus Maffei undertook to place orders in the Netherlands for military and civil goods for the other half, also totalling $56.4 million.[57]

The Norwegian purchase of the Leopard was within the framework of a remarkable arrangement concluded in 1960 between the German and Norwegian Governments. The arrangement involved a German commitment to purchase five Deutsch Marks of either military or civil goods from Norway for every three Deutsch Marks of military equipment that Norway purchased from the FRG, thus offering a considerable foreign exchange benefit to the purchaser to the tune of a 167% offset![58] These Leopard I orders were later followed by those of Denmark, Italy, and more recently Canada virtually making the Leopard I the NATO standard. Italy produced its Leopards under license (Mode #1).

2. Dassault and the Belgian and Spanish Offsets for the Purchase of the Mirage

Before getting into the specifics of either of these French offsets, it would be worthwhile to point out several of the unique characteristics of Dassault-Breguet that not only contribute to their propensity for such bi-lateral offset arrangements, but also tend to limit them more than other European aerospace firms to such forms of transnational collaboration.

The success and efficiency of Dassault-Breguet can, in large measure, be attributed to its small size and the concentration of its activities, as well as special characteristics of its unique management approach. One of Dassault's most important operating criterion has been its very heavy reliance on subcontracting.[59] This allows it to squeeze competing subcontractors on their prices (it being much more difficult to squeeze costs out of one's own operations), and it provides a cushion to keep the contractor's work force stable while avoiding over capacity.[60]

One factor contributing to the effectiveness of the Dassault organization with regards to single-engine Mach 2 fighters[61] has been the personal relationships of a small team of men of great ability and mutual confidence in one another. One key feature of such an organization is an absence of documentation. Marcel Dassault's management philosophy includes the view that a group of 2,500 employees is the largest in which the impact of a single leader can be felt.[62]

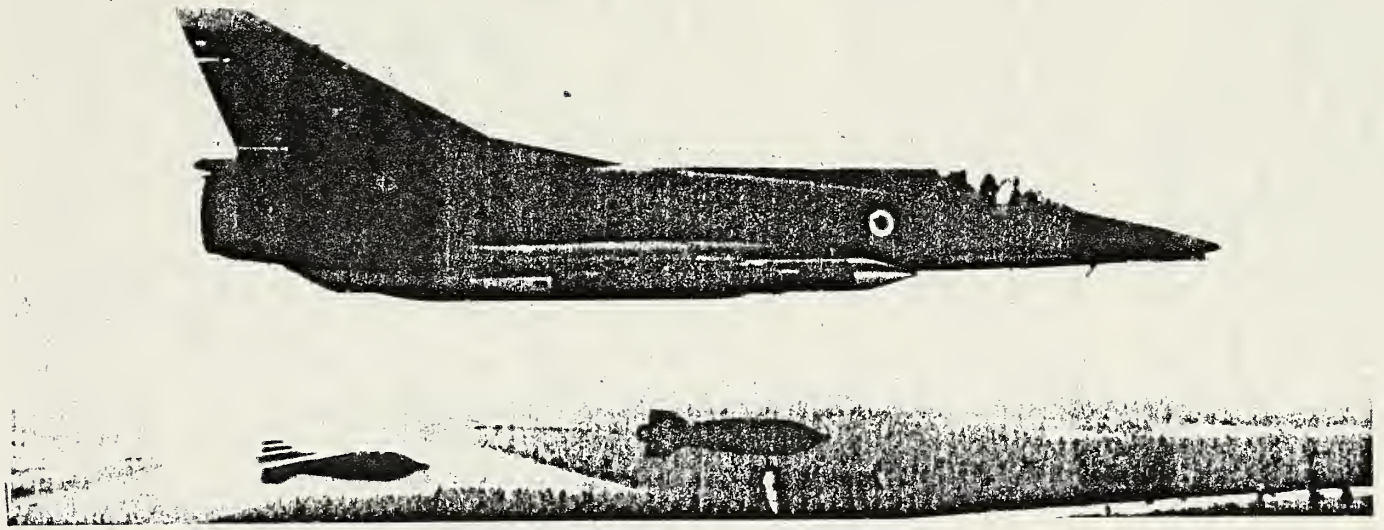
A high priority within the organization is also placed on resisting specialization, the view being that, while specialists tend to dig far deeper into their own narrow field, the ultimate result is that they lose the ability to communicate with other elements of the firm. While this view has its merits, it has been suggested that the resultant trade-off may lead to a lack of sufficient engineering depth to work on highly-advanced projects.[63]

As a result of the above characteristics of the Dassault organization, the French government has been heavily reliant on Aerospatiale as its instrument

in major collaborative projects. Although Dassault is often viewed as being obstructionist in terms of large-scale international collaboration on a parity basis, "the actual fact may be that it is not really very capable of adapting to larger scale enterprises with other partners, given the inherent personalities and organizational structures."[64] Therefore, Dassault has been specially adept at collaboration where it has been based on subcontracting to other smaller national industries on an ad hoc offset basis such as the Belgian and Spanish Mirage purchases. It must be remembered that Dassault inherited the Atlantic[65], Jaguar[66] and Alpha Jet[67] collaborative projects from Breguet as a result of their merger. Moreover, although Dassault-Breguet and Dornier are equal partners, for the most recent project, the Alpha Jet, Dassault was still the prime contractor, and France played the lead role in the other two as well.

a. The Belgian Offset for the Purchase of the Dassault Mirage 5

In February 1968 Belgium selected the Dassault Mirage 5 ground support aircraft over the Northrop F-5 and eventually placed an order for a total of 106 Mirages. This was considered at the time to have been a significant step in the successful French drive to establish themselves as the leaders of the European aeronautical industry. This sale broke a virtual aircraft monopoly held by the U.S. in continental Europe since WW II. This also was in the wake of the French withdrawal from NATO and the beginning of a less U.S. dominated alliance, and at the peak of the French government and industry's crusade to counter 'Le Defi Americain'.



Largage de bombes freinées par un Mirage V F (BCRE).

Of significance here is the nature of the French offer that contributed to the success. Much of the success of French industrialists in competing in Europe, South America, Africa and the Mediterranean area since the mid-60's can be attributed to carefully laid basis of industrial, financial, and cultural cooperation. Add to these the political constraints on U.S. sales in many of these areas and the agressive support of the French government generally, and more specifically the better credit terms offered. These arrangements have had the effect of developing strong working relationships.

The Mach 2.2 Dassault Mirage 5 ground support aircraft is essentially a Dassault Mirage 3E jet fighter developed for the Armee de l'Air, but with a simplified avionics system. Both are powered by the Snecma Atar 9C.[68] The Mirage 5 was designed specifically for the export market, since France did not plan on buying any of the aircraft.

The U.S. Defense Department, for its part in the F-5 proposal, offered Belgium a maximum 50-50 split in production of the aircraft. There was criticism, however, that the American government had given up on the project several months before and failed to push its case until the last. This left Northrop alone in competing with the strong French government and industry effort in the crucial final months of the competition. When the French buy appeared imminent, the DoD did make an attempt to persuade the Belgian government to take past American aid into consideration, but to no avail.[69]

Pressure for selection of the F-5 came not only from the U.S. but from the Dutch government and aerospace industry as well. The Dutch, who had recently

ordered the Northrop F-5 had been originally teamed with the Belgians to make a common buy as they had with both Meteor and Hunter selections in the late 40's and mid-50's both for joint production purposes and for continued standardization of the two air forces. The Dutch and Belgians had joint pilot training schools and owned some jet trainers jointly.[70] However, Belgian budgetary problems had resulted in a delay and the Netherlands had to go ahead with a selection on its own. In spite of this, the Dutch were still hoping that the belated Belgian decision would still allow for commonality of equipment. This Dutch-Belgian teaming relationship had also been critical in expanding the F-104G program from a German only program to a NATO program. The Belgium-Netherlands team was later to form the core of the buying consortium that led to the F-16 Multinational Fighter project.

The Belgian order was for 88 Mirage 5's with an option for another 18 aircraft, one that was later filled. The Belgian order, valued at $150 million ranked as the largest single military export order in French aerospace history. Nevertheless, the price in offsets for the French industry was high, with some observers at the time doubting their wisdom.[71] The offset production agreement provided Belgium was industry provided and included a mix of both internal and external offsets. Belguim's aircraft industry—SABCA (50% owned by Dassault), Fairey and Fabrique Nationale—built 50% of the Belgian Mirage 5's. As this represented the limit of cost/effective participation by Belgian industry in the production of its own aircraft, external offsets had to be introduced to cover another 20% of costs. These included: involvement in the ill-fated Dassault Mercure short-haul transport program; work on the Jaguar's Adour engine;

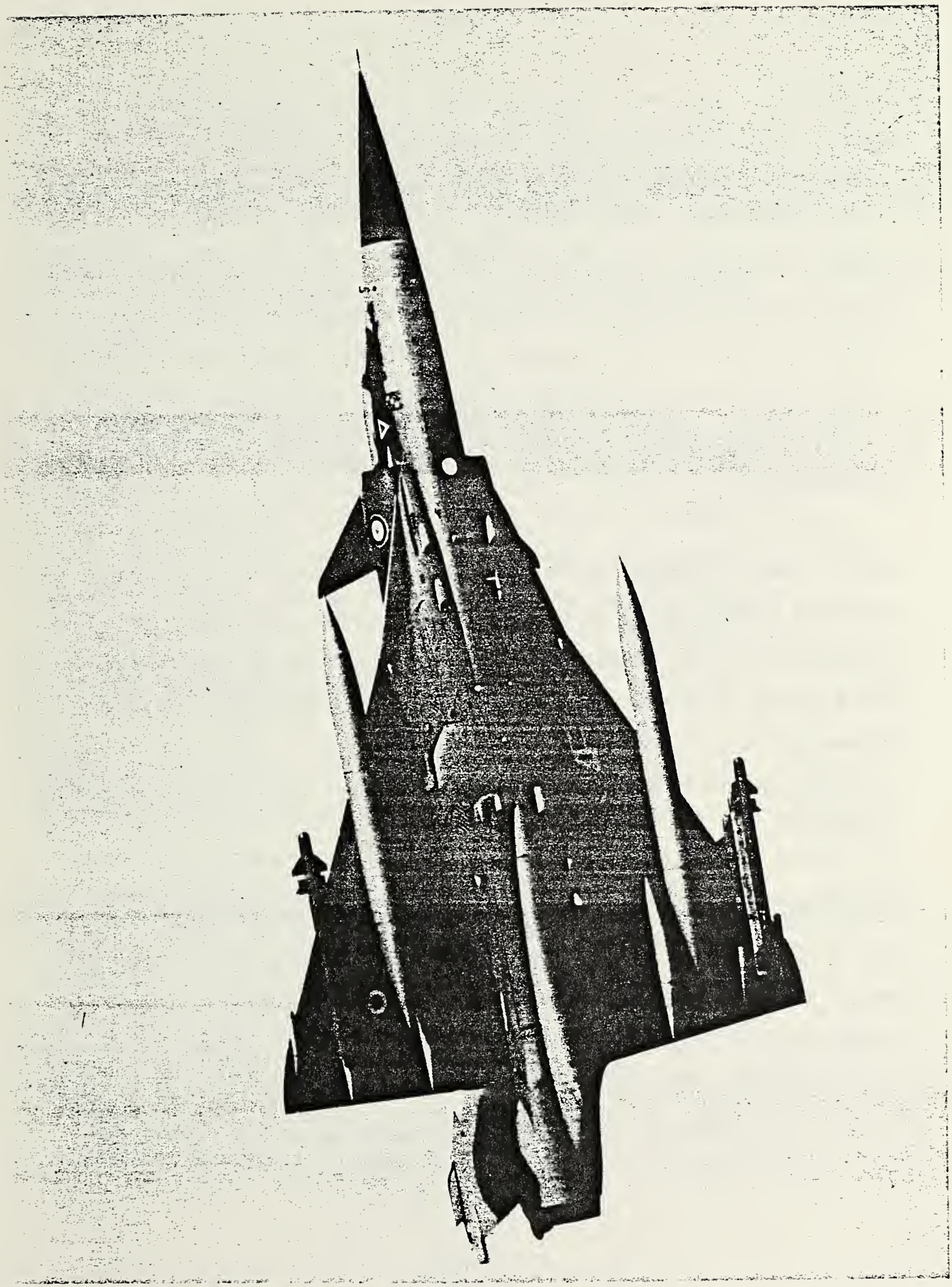
piece work on the Mirage F-1; and the possiblity of participation in the final development and production of the Jaguar. Twenty-six million man-hours of work were guaranteed totaling 70% of the purchase price.[72]

The fact that the Belgian government was under a caretaker government (nothing unusual) at the time of the decision in February, tended to complicate the picture on the precise number of aircraft to be ordered by Belgium, and as such substantial funding could not be committed until a new government was formed. Around $15 million was available, however, from the former government for starting the program. Belgium's coalition government had collapsed earlier in the month over the usual burning issue that has led to the collapse of many governments before and since, language based disputes between the Dutch speaking Flemish in the north and the French speaking Walloons in the south. Premier Paul Vanden Boeyants, who resigned but remained as head of a caretaker government, told firms involved in the Mirage 5 program, that the order could be considered firm, since it had been under negotiation for the previous 18 months.[73]

b. Spanish Mirage 3E Purchase and the Concomitant Offset

The Mirage 5 sale to Belgium in early 1968 was followed two years later by another similar but scaled-down industrial offset agreement between Dassault and Spain's CASA in 1970.

Spain selected the Dassault Mirage 3E over the McDonnell Douglas F-4 in a competition in early 1970. The Spanish order was for 30 Mirage 3E's, the choice



Le Mirage III NG, ici armé de Magic, sera une vedette du 35e Salon (Doc Aviaplans).

again being in good part influenced by the aerospace industry internal and external offset package offered. Dassault agreed to place 6.3 million man-hours of work with the Spanish aerospace industry. This amounted to some 20% of the $90 million value of the Mirage contract. CASA built 45% of the Spanish Mirage airframe and received work on the Mercure as well.[74] The French Government also threw in an offset of a more purely long-term political nature. France agreed to be Spain's sponsor in its efforts to join the EEC (later to become a very ticklish affair, as France (and its agricultural industry) in fact by the late 1970's had become the principal obstacle to Spanish membership).[75]

Spain's overall objective in demanding an industrial offset was one common to most such offsets and indicative of the direction that the European aerospace industries have been taking. The explicit objective was to further develop the 5,000-man Spanish aerospace industry so that it could be a full partner in future collaborative European programs.[76] (A successful policy that led shortly thereafter to Spanish membership in Airbus Industrie through the participation of CASA.)

An additional factor contributing to the selection of the Mirage 3E over the F-4 is noteworthy. Similar to the prior competition in early 1968 when the Mirage 5 won out over the F-5 in Belgium, is the role played (or better yet, not played) by a component of the U.S. Government. This role was also somewhat indicative of the priority given by the U.S. Government at that time to timely action in the promotion of U.S. military exports and related cooperation.

Spain's original preference for the F-4 reportedly shifted toward the Mirage 3E as a result of the Export-Import Bank having delayed action on a loan application until after Spain had already been forced to commit itself to buy 30 Mirage 3E's. French salesmen quickly moved into the breach with the Mirage offer when it became apparent to Spain that the Export-Import Bank was sitting on its loan.[77]

Although the loan was ultimately approved, it was too late for the F-4 deal, and only after repeated requests for a decision. The Bank's attitude toward the loan was characterized by one observer as cavalier. An urgent request for a decision when it would have reportedly resulted in the purchase of the F-4, brought the response that the official handling it was on vacation.[78]

3. Danish Purchase of the Swedish Draken

The sale of the Sweden's Saab-Scania J-35 Draken fighter to Denmark in 1968 followed a slightly different offset arrangement. In this deal, in which the Draken won out over the Dassault Mirage 5 and the Northrop F-5, the offset was an external non-military government provided one. As Denmark had no aerospace industry, the possibility of achieving an offset through partial production of the Draken in Denmark was considered infeasible. Instead, Sweden undertook the purchase of ships and food from Denmark, as well as technical and funding assistance for a supersonic airport on Saltholm island located between the two nations.[79] The French offset offer in the same competition was reportedly one involving the purchase of pre-fabricated housing units from the Danes.[80]

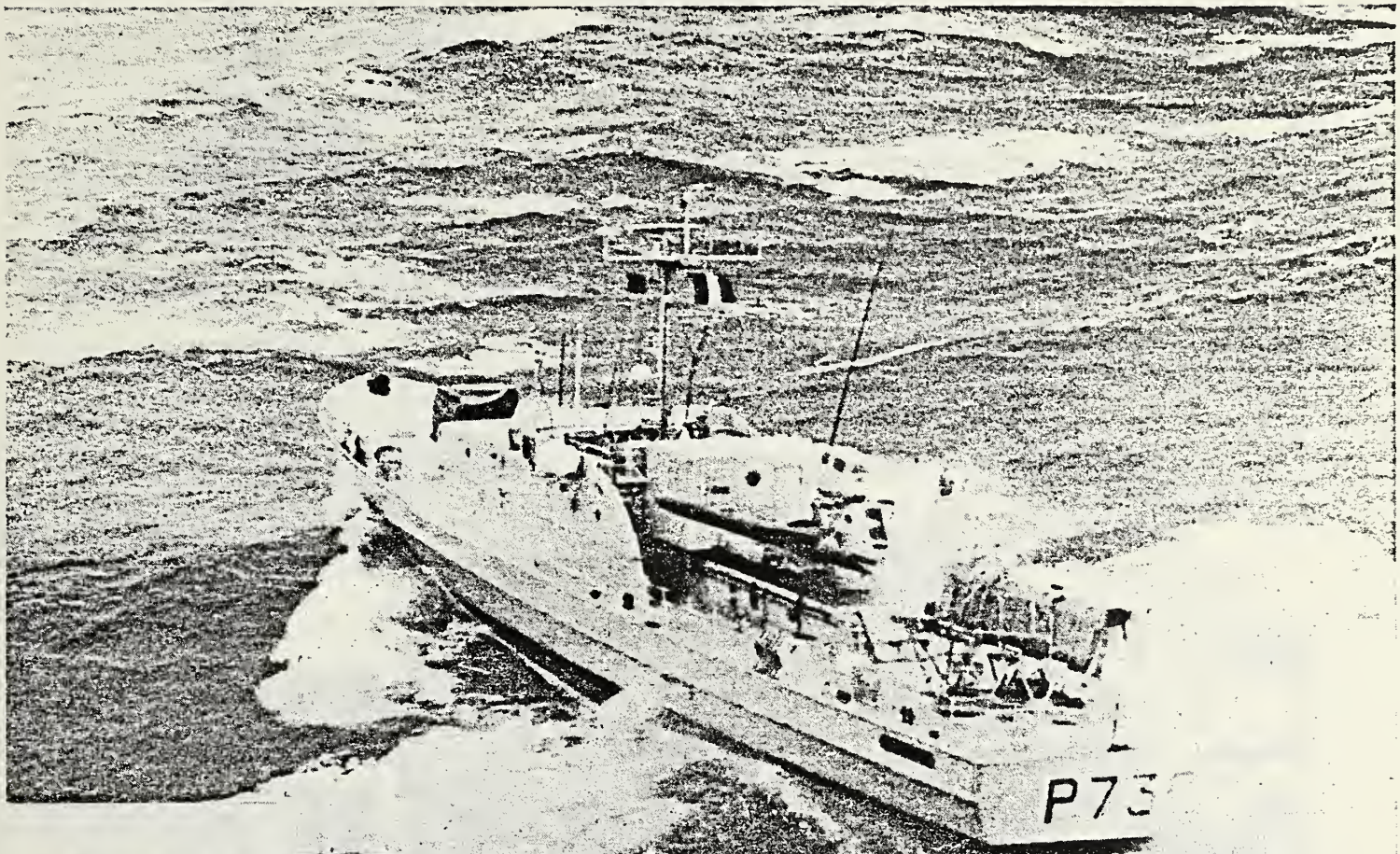
These offset terms offered by the Swedish Government reportedly played an important role in the selection of the Draken.[81]

4. The British Exocet (MM-38) Buy

In the late 60's Britain found itself without an anti-ship missile, at a time when many other navies were hurriedly arming themselves with such a weapon. In approaching France for a possible purchase of the Exocet, Britain expressed an interest in participating in some part of the production of the missile as well as some external offset. France agreed to a work sharing agreement and BAC was selected by the British government to be the British partner of Aerospatiale's missile division and Thompson-CSF, the developers of the missile.[82] Several other British firms are also involved in the production of subassemblies of the missile. As a governmental external offset, France bought the Rolls Royce Olympus gas turbine engine.[83]

In addition, U.S. industry was involved with the Exocet in varying capacities. Sperry was selected by Aerospatiale as subcontractor for the missile's coordinate calculator. The Sperry calculator was embodied in some 80% of the missile systems sold as of 1976, as part of the missile's fire control system. Thompson-CSF as well makes a fire control system for Exocet which also includes a calculator. This one has been bought by some nations in lieu of the standard Exocet fire control system.[84]

Another U.S. firm involved in the project was the Boeing Aerospace Company, which obtained the U.S. Exocet license in 1971, as part of an effort to bring



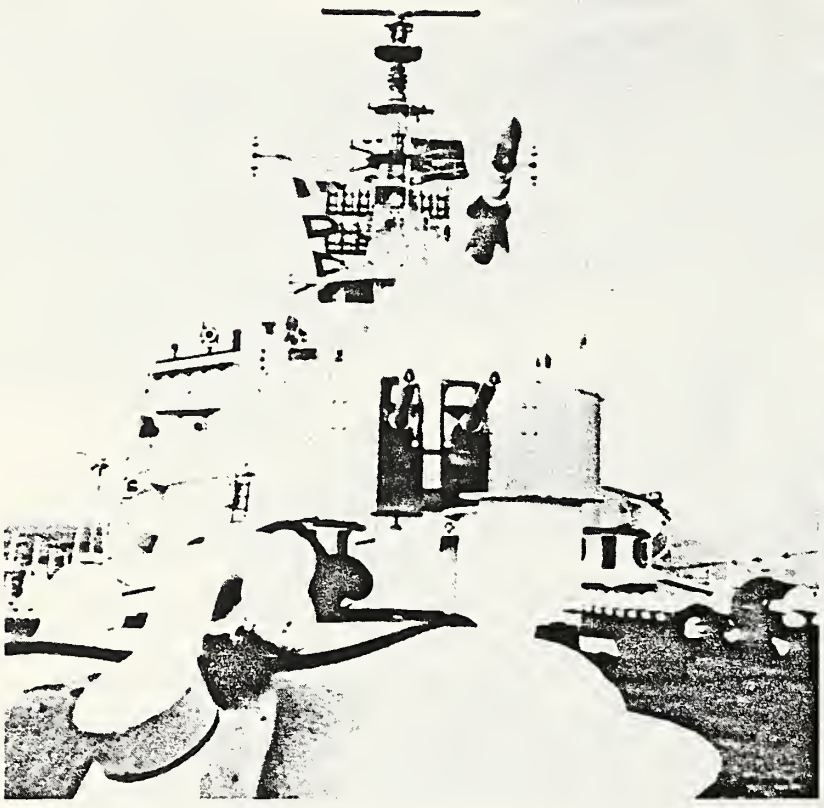
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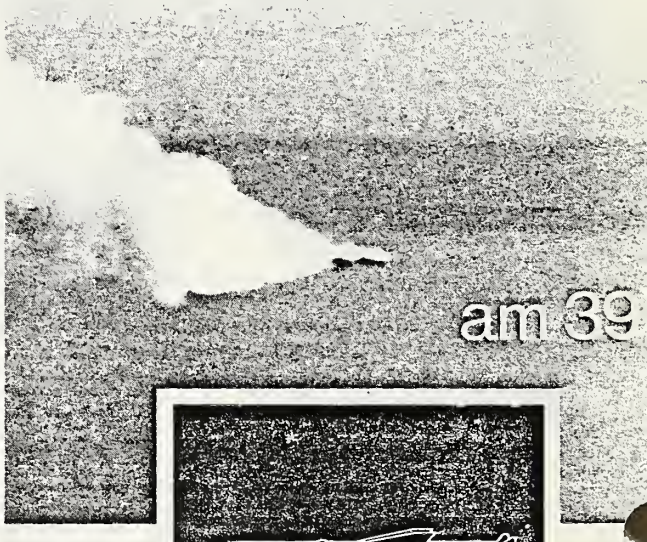
aerospatiale

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2, rue Béranger - 92 - Chatillon
Tél. 644-55-30 (France)

exocet
mm 38

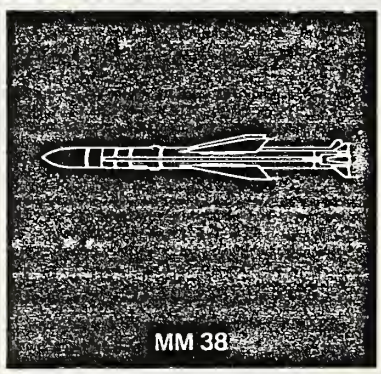




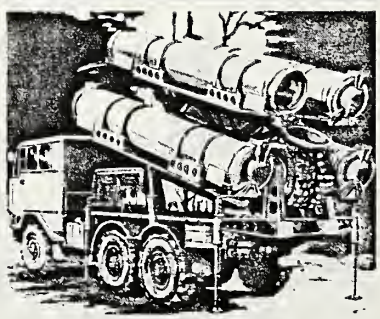


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MM 38


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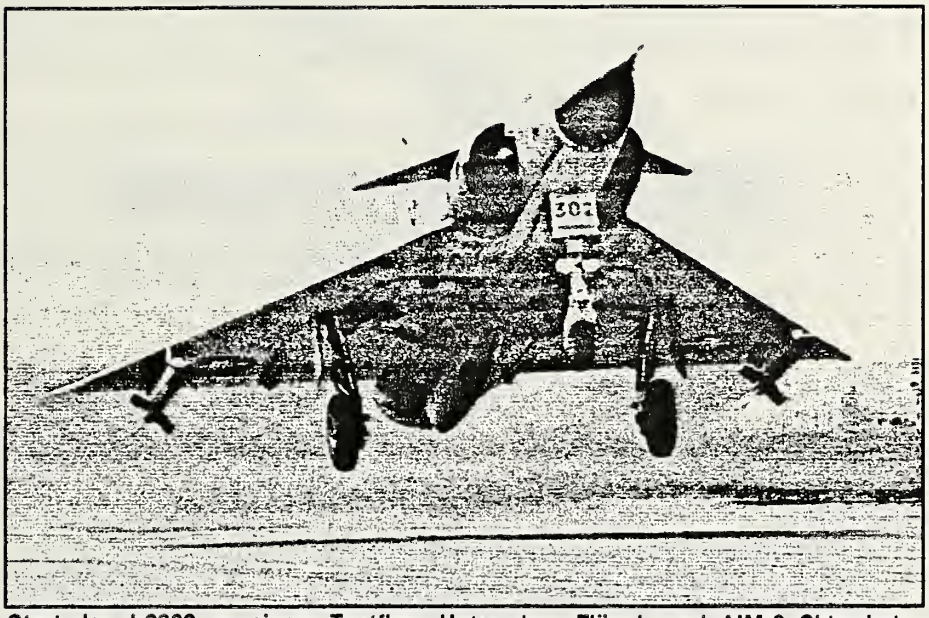
France into the NATO PHM project. Though Boeing was unsuccessful in selling the Exocet to the USN as an alternative for its Harpoon or getting the French Navy to join the NATO PHM project, the working relationship established did eventually lead to Boeing, teamed with Hughes, successfully selling the Aerospatiale/MBB Roland II to the U.S. Army several years later.

D. U.S. OFFSETS FOR EUROPEAN PURCHASES: 1975-79

1. The Swiss F-5E

After years of evaluation, the Swiss Government proposed in late August 1975 that Northrop be awarded an order valued at $486 million for 72 F-5E fighters. As a compromise between the undesirable extremes represented by the very costly prior Swiss licensed production of the Mirage III, or no work at all for the hard-pressed Swiss aerospace industry, a limited assembly program was chosen. The Swiss F-5's were assembled at the Swiss Federal Aircraft Factory at Emmen (Mode #1 of industrial collaboration). Delivery of the 72 aircraft took place between 1979 and 1981. In addition, the U.S. Government pledged its best efforts to make Northrop deliver on an agreement to offset purchases.

Cost overruns on the Mirage III built under license in the 1960's, had caused a major political upheaval in Switzerland. Cost per airplane soared from the original estimate of $1.84 million to $5.06 million, mostly owing to design changes ordered by the Swiss (e.g., there were interoperability problems between the British Ferranti radar and the standard avionics). The first major blow to the Swiss industry resulting from this backlash came when a Swiss government decision to purchase close support fighter-bombers off-the-shelf from an outside source was announced in June, 1970. Rather than pay the estimated 30% higher cost of producing the aircraft, the LTV A-7G Corsair fighter bomber, or even some parts of it, under license, direct purchase was opted for. At the time it was expected that this decision would force the eventual closing of the government-owned Federal Aircraft factory at Emmen.[85]



Start der J-2302 zu einem Testflug. Unter dem Flügel zwei AIM-9 Sidewinder



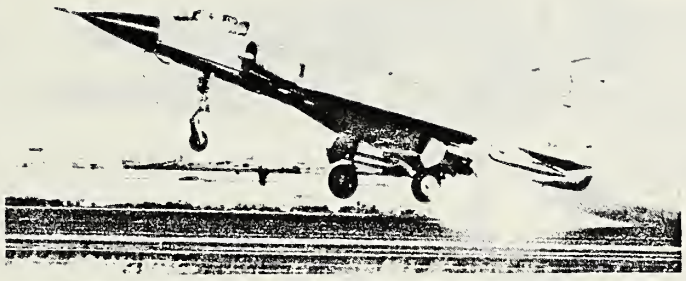
Dieses Bild zeigt den Canard-Versuchsträger Mirage IIIS (J-2302) während eines Testflugs irgendwo über der Schweiz. Gut erkennbar die beiden Canards, die das Langsamflugverhalten der Maschine erheblich verbessern.

Though the Emmen facility wasn't subsequently closed down due to successful diversification into space technology and civil aviation, for the F-5E Tiger II program in 1975, a middle course between a full fledged license production program (a la Mirage III) and off-the-shelf procurement (a la A-7) was selected. This involved final assembly only of sub-assemblies and components built in the USA and flown to Emmen.

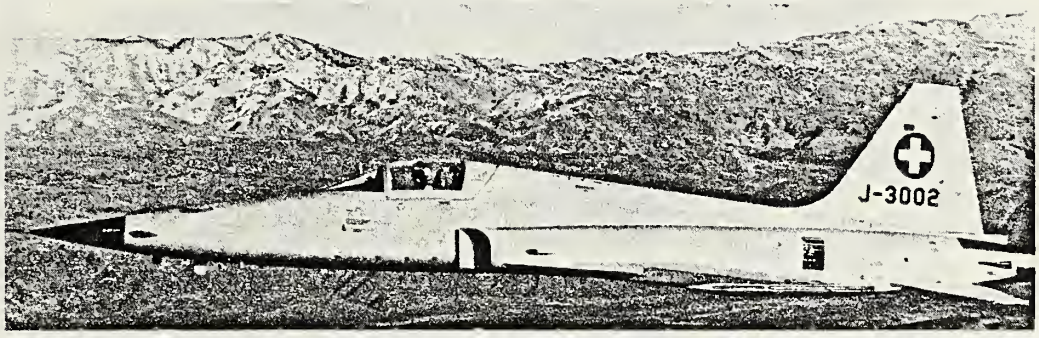
The Swiss contractors had previously been given an opportunity to compete for subcontracts on the aircraft program and were not competitive due to learning curve, low quantity requirements, and the high cost of extra transportation, packaging, etc. The consequent foreign exchange/job loss would be offset primarily through an external bilateral offset program (Mode #6 of industrial collaboration).

To nail down the contract in Switzerland for the 72 F-5's, Northrop made a unique commitment. In effect, it agreed to become a global sales agent for Swiss industrial products, ranging from machine tools to water purifiers. The company promised to find new business for Swiss manufacturers amounting to at least 30% -$136 million—of the fighters' cost over an eight-year period. Most of the Swiss companies that needed help were relatively small and lacked international experience outside of Europe.[86]

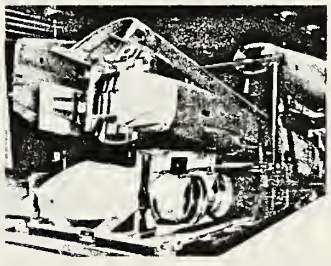
Consequently, Northrop set about establishing a special office in Switzerland, inventoried 800 Swiss companies and established a computerized library of

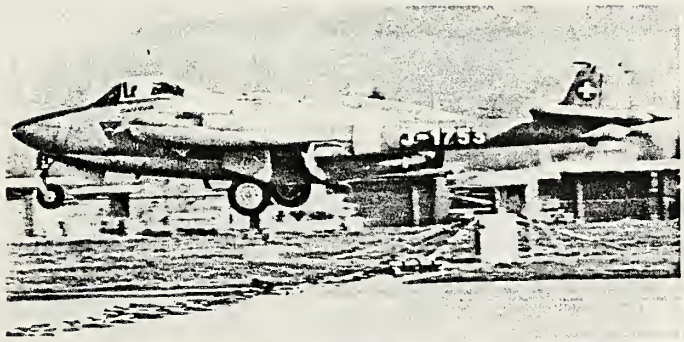


The MIRAGE III S – here on trial take-off with starting rockets – was produced in Switzerland in license and serves as interceptor.



The Swiss Air Force is being supplied with 72 F-5E TIGER fighters. The aircraft are delivered to Switzerland in components and then assembled there (photo right).





The VENOM will soon be replaced by the F-5. The number of squadrons will then be reduced from seven to three.

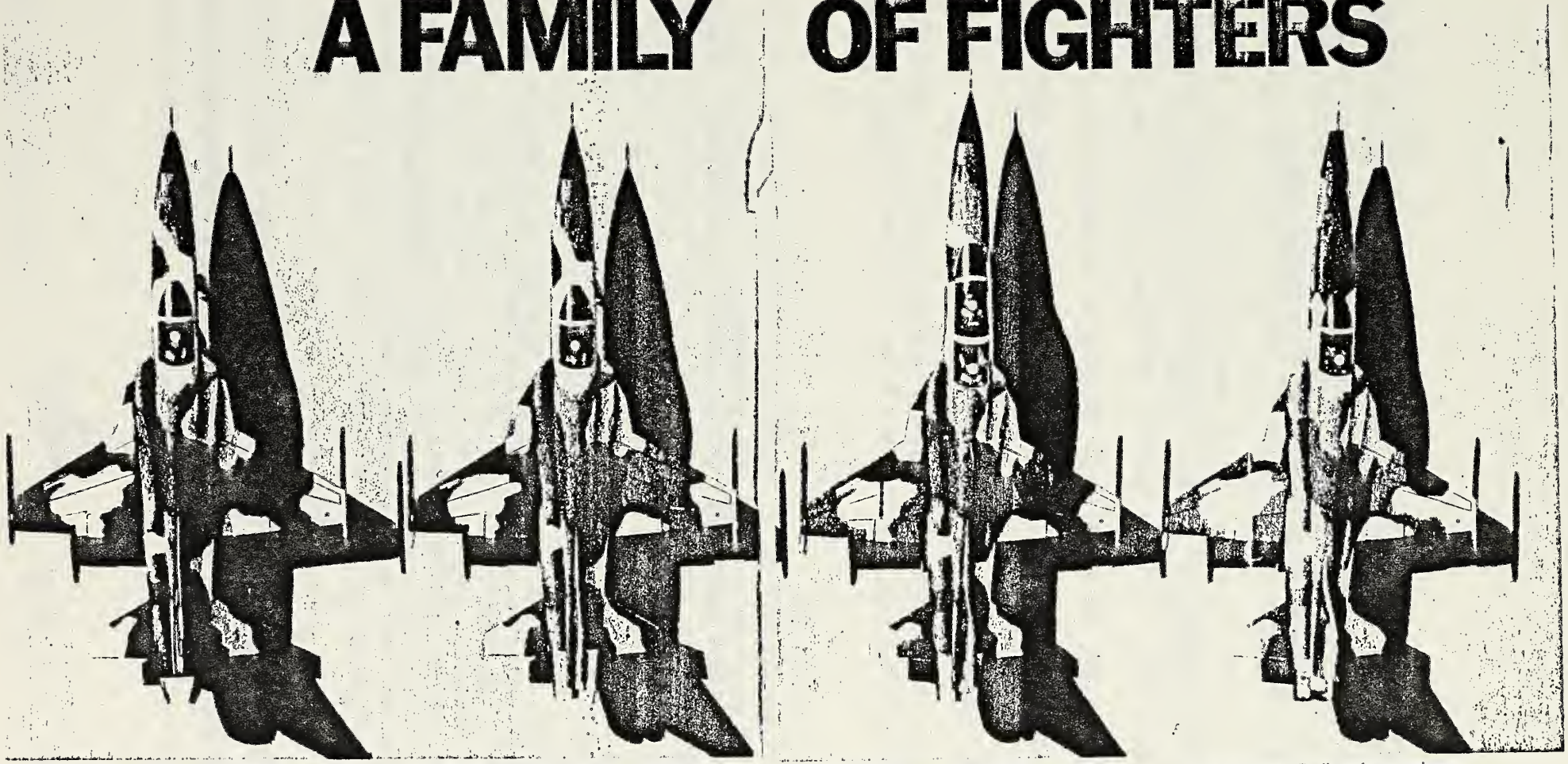
exportable Swiss products at Northrop headquarters in California. Northrop representatives all over the world were told to be alert to markets for the Swiss products. As part of this effort, Northrop was later able to help Swiss companies sell elevators to Egypt, precision drills to Spain,[87] shelving to Saudi Arabia, and hoses to Mexico.

Therefore, for Northrop, the Swiss Offset program is primarily a marketing effort.

General Electric, the manufacturer of the F-5's J79 engine also participated in the offset deal. Because of General Electric's size and the scope of its product line, however, they accomplished their portion of it through their own purchasing agents. This has involved the purchase of, among other things, precision machinery.

As a backup, the Swiss government insisted that the U.S. provide a guarantee. Consequently Swiss-Northrop Offset program involved a Memorandum of Understanding signed in July, 1975 between the U.S. and Swiss governments. This MOU obligated a reluctant U.S. government to exert its "best efforts" to induce its participating contractors to buy or market Swiss goods internally or with third parties, to a minimum of 30% of the costs of the Swiss procured program over an eight year period. In the view of the DoD the principal responsibility for implementation of the MOU rests with the industrial beneficiaries - Northrop and General Electric.

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Inasmuch as offsets transcend the normal contracting management parameters of the SPO, they impose responsibilities beyond the possible control of the SPO. The Swiss offset is therefore being managed by a DOD/USAF team.

This MOU had been entered into after the contract for the Swiss Co-Production program was negotiated. Although the U.S. Government stated that it entered into the program under the belief that the cost of implementation was to be borne solely by these same beneficiaries, the contractors did not originally concur.

An April 1978 article in Fortune by Louis Kraar described the Swiss offset program as,

> "one of the most ambitious of such arrangements. Though other aerospace corporations have agreed to buy products from customers, they have never promoted them around the world. But the meticulous Swiss persuaded the Pentagon, which must approve major military exports, to pledge its 'best efforts' to make Northrop deliver the promised marketing assistance. The company is fully aware that its credibility is at stake in its unusual sales campaign for the Swiss."
>
> "George Reed, Northrop's offset-program manager, has picked up the know-how of a trading company, he says, 'sometimes painfully.' Discovering 'no reasonable catalogue' that fully represented Swiss industry, he had to compile and distribute a directory listing 800 companies. After fruitlessly dealing by mail and telex with would-be Swiss exporters, Reed opened a Zurich office. 'Since there's little that anyone can show Nestle and Sulzer Brothers about selling abroad,' he says, 'we end up working with firms that have limited marketing experience."[88]

Taking the most direct route first, Northrop bought Swiss electric cable, office equipment, and even paper clips. Every division of the corporation, in fact,

has a yearly dollar target for buying from Switzerland. Reed also placed a $294 order for small versions of the famous Swiss Army knives, which he hands out to promote the offset program. In the U.S., the steady rise of the Swiss franc against the U.S. dollar has made it more difficult for Swiss manufacturers to be competitive during most of the late 70's, a requirement of the offset deal.[89]

Although the Swiss F-5E deal was obviously by no means the first offset deal, it was unprecedented in at least one respect. Northrop pioneered the marketing of a full range of customer country's products to third countries in return for armament sales.

Between 1975 and 1980 Northrop was successful in helping 200 Swiss companies find markets for $209 million worth of products, mostly outside the United States.[90]

On July 1, 1981, Northrop won another Swiss order for 38 more F-5s, thereby bringing the total Swiss order to 100 aircraft.

2. Belgian MAG-58 Armor Machine Gun

In the spring of 1976 the U.S. Army selected the Belgian MAG-58 to replace the current U.S. 7.62 mm armour machine gun for future employment in the M-1 tank turret and other armored vehicles. The U.S. Army awarded a two-year contract to Fabrique Nationale (FN) of Belgium for 10,000 MAG-58 (designated M240 by

the U.S. Army) machine guns and the Technical Data Package for $55.5 million. The first 300 weapons were delivered to the U.S. Army in December, 1977. Maremont Corp., the Army's previous sole supplier was expected at that time to win the order for follow-on-production of approximately 16,000 MAG-58 machine guns (which would be produced under license), the U.S. Army having planned to issue the requests for proposals in 1978. However, Fabrique Nationale was again selected in September 1979 over Maremont. Fabrique Nationale had since begun to set up a U.S. subsidiary in Columbia, South Carolina, Fabrique Nationale Manufacturing, Inc., where this follow-on order was to be ultimately produced (a variation of Mode #4).[91] The second award to FN involved a five-year $62,256,161 buy.[92]

The direct purchase in quantity from Belgium, to be followed by possible licensed production in the U.S., was also entangled in a larger issue. This selection of the Belgium weapon was commonly understood to be intimately associated with the selection by Belgium of the F-16 over the French Mirage F-1 the previous year. Though not explicitly linked as such by the U.S. government, this was viewed by the Belgians and many American observers as an external U.S. government provided offset thrown in as a last minute sweetner to overcome Belgian resistance to a U.S. buy during the competition, one in which Belgium was the last hold out (per usual) in the four nation consortium selecting a common fighter.[93] The court action that was initiated by Maremont Corp., the loser of the competition, following the selection of the Belgian gun, displayed the ambiguity of operating within a highly structured and protected national defense contracting environment that places a premium (at least

theoretically) on competitiveness in the selection of a given system, while simultaneously having to wheel and deal at the Alliance level in finding politically acceptable, yet cost-effective trade-offs in line with considering the more diffuse benefits of NATO Standardization.

The Maremont Corp. of Chicago, whose machine gun production facilities are located in Saco, Maine (where some 600 jobs were at stake), plus all four Congressional delegates from Maine, unsuccessfully tried to block the procurement, but were only successful in temporarily holding it up. Maremont Corp. and the Maine Congressional delegation filed suit in Federal District Court in late May, 1976, to seek an injunction against American purchase of the foreign arms. They succeeded in obtaining a court injunction in early July contingent upon the findings of the GAO. Maremont had contended that the Army had violated the Buy American Act and federal procurement bidding procedures. They also claimed that the Army had violated the specialty metals clause of Section 723 of the 1976 DoD Appropriations Act, and claimed that the Army had promised Belgium the gun contract in exchange for the Belgium purchase of the F-16. Maremont, the sole American bidder, bid its contract at $37,260,800, compared to the $55,466,000 winning bid of FN.[94]

Although the U.S. gun had rated higher in service-life tests and lower in estimated costs, the Pentagon said the Belgian entry excelled in reliability and operational effectiveness.[95] The Pentagon further denied any connection between the F-16 agreement and the Belgian MAG-58 deal.[96]

In the end, the GAO upheld the Army's selection.

3. The German 120 mm Smoothbore Gun for the XM-1

In late January, 1978, the U.S. Army decided to adapt the FRG's 120 mm smooth bore gun for its new Chrysler M-1 main battle tank—selecting it over the British 120 mm gun. The gun is to be produced in the U.S. under license (Mode #4). This decision was significant in that it bore on two very important U.S. NATO related programs both involving the "two-way street" issue. These are the M-1 and the NATO AWACS programs.

As it related to the aborted 1974-1976 attempt to consider the Leopard II as an alternative to the M-1 as the next generation U.S. main battle tank, the gun represented an attempt at salvaging the prior effort in some measure. It also represented a possibly significant and much more feasible alternative to standardization at the system level, i.e., standardization (or at least interchangeability) at the level of critical subsystems or components.

With regards to the NATO AWACS program, the FRG was expected to be funding around 60% of Europe's half in the program. Consequently, as with the British F-111K order, the FRG was demanding some significant external offset of a high technology nature, before agreeing to fund its share in the 18 aircraft procurement.

Though the quid pro quo could not be an explicit one, some significant U.S. gesture was called for. The offsetting acquisition had to be an external one

due to the difficulty of introducing an internal offset at a late stage into such a high technology program involving a small quantity of systems.

Though the possiblity of such a gesture involving the tank gun, or the German Gepard Flakpanzer, had been in the air for some months, the first the Germans knew of a decision was on January 20, 1978, when Secretary of Defense, Harold Brown, telephoned his German counterpart, Georg Leber, requesting an urgent meeting. An American delegation headed up by the Assistant Secretary of the Army arrived in Bonn, the next day. Negotiations with the Bonn Government and the gun's manufacturer, Rheinmetall, continued through the weekend. The negotiations concerned the details of transferring the technology and or licensing arrangements necessary for production of the gun in the U.S. The Army announced its decision on January 31.[97]

Opinion within the U.S. Army and Congress was split over the issue. Some within the Army would have prefereed to stay with its present British-designed 105 mm gun, even though trials the prior December showed clearly that the German gun had greater hitting power. In Congress some members also favored the 105 mm gun, and damned the decision to buy German as 'political'.

In any case there were very substantial reasons for opting for the 120 mm gun at that time, as well as picking a German gun. Even though U.S. Army's current gun was more than adequate at that time, it couldn't match the German smooth bore gun in dealing with the future threat.[98]

In response to renewed concern over NATO Standardization and the "two-way street" policy, the U.S. had offered in late 1974 to open its national tank development program, the M-1, to the FRG's Leopard II tank, both of which had emerged from the aborted U.S./FRG MBT-70 program (much as there had been a competition between the two tanks emerging from the earlier aborted Franco-German tank program). After a string of 'volte face' over the next two years, the runoff between the M-1 and the Leopard, which was to be followed by license production in the U.S. (Mode #4) by FMC if the Leopard was the one selected, never took place. Instead, the two governments agreed that certain Leopard components would be evaluated along with those of Chrysler—the winner of the U.S. competition—so as to identify those which might be made standard or interoperable for both the M-1 and the Leopard II. This opened up the possibility of a cross licensing arrangement for critical subsystems. The efforts focused on a common track, night vision devices, metric fasteners, diesel fuel, and the fire control system. Moreover, the U.S. had agreed to modify its version for possible adoption of the German or British 120mm gun, while the Germans had agreed to consider the gas-turbine engine for its future Leopard's. Although, the selection of the German 120mm gun improved the chances of an eventual selection of the American turbine engine (which reportedly many German officers wanted anyway), a GAO report of late 1977 was pessimistic on the chances of the qualification of any further subsystems beyond these two.[99]

In announcing its decision to adapt the German 120mm gun on January 31, 1978, Army Secretary Clifford L. Alexander, Jr. told a Pentagon news conference that the driving factor in selecting the German gun over the British 120mm gun was

that it would advance the prospects for interoperability of the next generation of tank guns within the North Atlantic Alliance, considering the larger German tank force.[100] At least NATO's two largest armies would use the same gun and ammunition - no minor point. Especially, if the Leopard II is adopted on as wide a basis among the NATO forces as was the Leopard I (FRG, Italy, Belguim, Netherlands, Denmark, Canada, and Norway) which seems highly probable.

The Army Secretary also said that the January negotiations with the Germans were limited to the gun and not linked to any commitment by the Bonn Government toward agreeing to fund its large share of NATO's purchase of the Airborne Warning and Control System (AWACS) which it had held out on for several years.[101] But the gun deal did improve the atmosphere for the Boeing E-3A AWACS purchase since the Germans had previously made it clear that they were awaiting a significant U.S. gesture in support of its verbal endorsements for the "two-way street" concept. Attention having previously been focused on the U.S. Army's Leopard II/XM-1 competition, in this regards, it was hoped that this gesture would mollify German public opinion.[102] Later that year the Bundestag's Budget Committee finally approved funding of the German share of the NATO AWACS project.

U.S. development and test efforts on the 120mm smooth bore gun were not expected to be resolved before late 1981. Design modifications as well would be required to reduce the cost of producing the gun in the U.S. and to take advantage of ammunition advances. With the completion of development work it was expected that M-1 production with the 120mm gun could be initiated in 1984, in time for the out years of the 3300 tanks in the M-1 $4.8 billion program. First deliver-

ies of the M-1 were expected during the 1979-1980 time frame. Though the prospects were for the German gun being in only a minority of these 3300 tanks, the Army says it will eventually need twice the number of tanks provided for under the original program.[103]

The German gun will be produced in the U.S. at the Watervliet, N.Y., Army Aresnal, under license from Rheinmetall (Mode #4). Under terms of the licensing agreement, Rheinmetall would receive royalties amounting to 3% of the cost of producing the tube up to a maximum of $25 million for domestic production. For export production, the amounts would be 5%, and $25 million.

In the wake of the Leopard/XM-1 competition, the tank gun had previously become the center of considerable controversy and political maneuvering. The House Armed Services investigations subcommittee chairman, Rep. Samuel Stratton, who had been a vocal opponent of any accommodation with the Germans connected with the tank or gun, stated in an October 1977 report that the gun "must be made on the basis of merit, not political considerations."[104] The subcommittee's reaction was dampened somewhat by the fact that the German gun was to be produced at Watervliet, located in Stratton's congressional district.

4. HELIP and Belguim

Raytheon was awarded the preliminry HELIP contract in January, 1974, receiving the final contract several months later, in May. Belgium retained an option to purchase before February 1, 1974, but did not exercise it, thus being the

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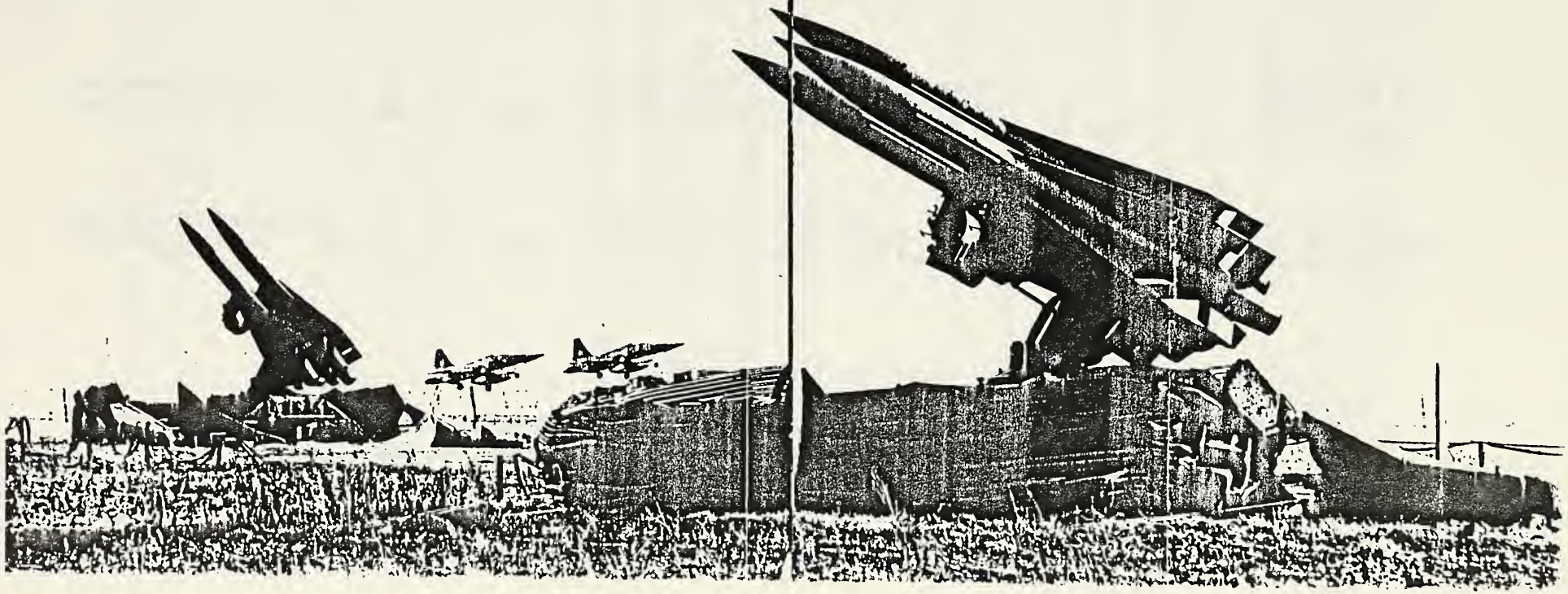
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NATO HAWK PROJECTS

	Years	Value	Prime Contracors for NATO - Europe Programs	Procuring Authority	Participating Nations
NATO Hawk (Basic)	1958-67	$670M	Paris based Societe Europeenne de Teleguidage, SETEL, co-owned by five national prime contractors: ACEC (Belgium); AEG (FRG); Philips (Netherlands); Selenia (Italy); and Thomson (France)	Five National Governments and the NHPLO[1]	Belgium, France FRG, Italy, Netherlands, (& U.S.[2])
Hawk European Limited Improvement Program (HELIP)	1967-80	$750M	Raytheon's Paris based subsidiary RAYTAS, subcontracting 40% of work package to Italian, Dutch, French and German firms	NHPLO[3]	Denmark, France FRG, Greece, Italy, and Netherlands[4]
Hawk European Product Improvement Program (PIP)	1980-84	$150M	GRIP (a Groupement d'Interet Economique, co-owned by MBB and Thomson) subcontracting to firms of all seven participating nations	NHPLO	Belgium, Denmark, France, FRG, Greece, Italy and Netherlands

[1]Under the auspices of the NATO Council, the five European States organized the NATO HAWK Production Organization consisting of a Board of Directors (BOD) and a Management office (agent of the BOD) to direct and supervise the NATO HAWK Production Program. The Board of Directors consisted of representatives from each of the five participating governments. Procurement was made by each of the countries through SETEL, an industrial consortium organized by the five National Prime Contractors. In 1963 the NHMO and BOD became known as the NATO HAWK Production and Logistics Organization (NHPLO). This organization contracted for and managed the programs for all participating governments for the HELIP and the Product Improvement Programs.

[2]The U.S. also participated in NHPLO as the government owning the Technical Data Package being transfered to the NATO - Europe consortium, i.e., as a non-voting member except in the areas of security and configuration control, where the U.S. maintained the right of veto. The U.S. was also a procuring government (through grant aid) for those Hawk systems built by SETEL for deployment by two additional NATO member states, Denmark and Greece. (Spain, a future NATO member state, also received Hawk systems through grant-aid, but off the U. S. production line.)

[3]Greece and Denmark later joined the NHPLO and participated directly on their own behalf in the procurement of the Improved Hawk (HELIP) and European Product Improvement Program (PIP).

[4]Belgium did not join HELIP until 1979 as the project was winding down, entering under special arrangements that include several bi-lateral offset arrangements, which amounted to a guarantee of 100% flow-back of expenditures totaling approximately $100M. (See Chapter 11.)

only NATO nation with the older Hawk system not to replace it with the Improved Hawk (See Chapter 12 for the HELIP project history). Negotiations over its participation were to drag on internationally as well as continuing to be a major political issue domestically over the next five years. To cite one example, in February, 1978, the Belgium Vice-Premier for Defense, threatened to resign if his socialist coalition partners continued to oppose the appropriation of $120 million dollars for the purchase of the Hawk, since Belgium urgently needed these missiles to fulfill its NATO commitments. The socialists, however, considered the economic and financial situation faced by the nation precluded any such expense.[105]

With Belgium's governmental crisis in the Autumn of 1978 over the issue of Walloon and Flemish local autonomy, a pending decision on a Belgian purchase was further delayed. NATO was continuing to face the prospect of a 60 km gap in the Hawk belt across the FRG. (The same governmental crisis also held up Belgium's approval for NATO's procurement 18 AWACS aircraft, for which Belgium was to contribute 3.5%).[106]

In late January 1979, the Belgian inter-ministerial committee finally voted to acquire the Raytheon Improved Hawk. The purchase will be offset by an agreement for 100% in economic benefits for Belgium. The cost of the program was around $140 million.[107]

A key element of the purchase agreement was a U.S. DoD agreement to waive the Buy American Act provisions on Belgian products in the high technology and

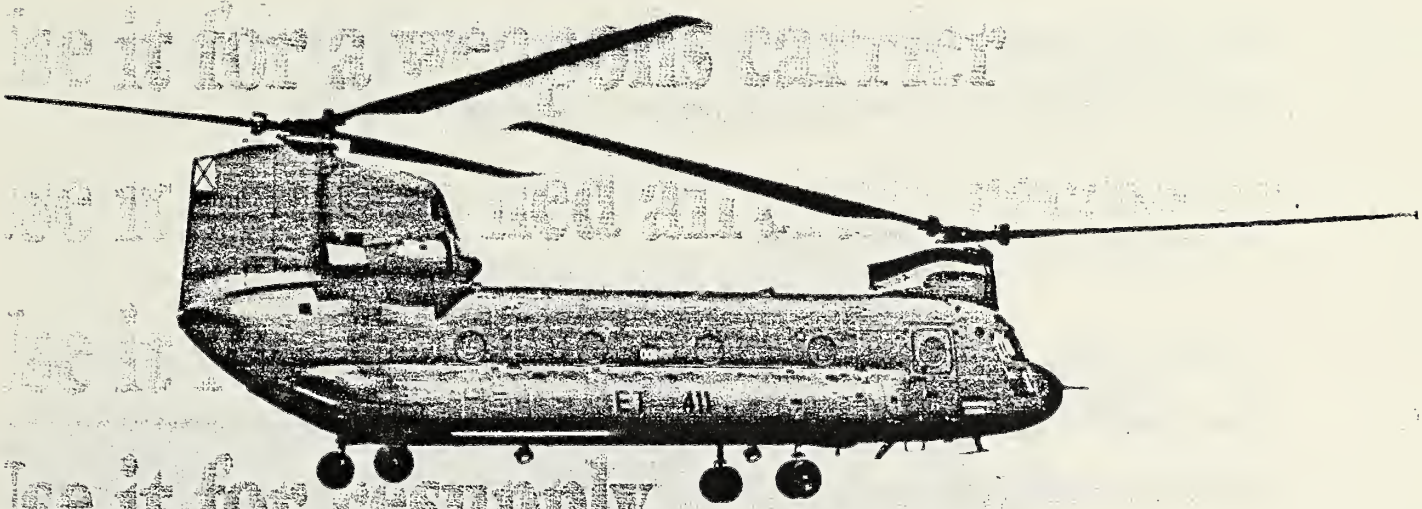
civil industrial field, which had recently been proposed by Defense Secretary Harold Brown in order to break the impasse over deployment of the Improved Hawk surface-to-air system.

According to the 100% compensation agreement, the U.S. will allow 60-67% direct Belgian participation in the program, with the Buy American Act exemption picking up most of the difference. In addition the German Government will also compensate Belgian industry to reinforce the overall economic package.[108] Italian industry also helped out by surrendering its pro rata share of the follow-on Hawk European Product Improvement Program in return for its share of the Belgian add on to the HELIP program.

As the Belgians had previously found out with their selection of the F-16, the last holdout in a cooperative procurement effort, gets a pretty good deal. Will they apply this same lesson to their more recent tergiversations over NATO AWACS funding?

5. Offsets Accompanying Purchase of the Boeing Vertol Chinook

The diversity of offset arrangements possible is well illustrated by those accompanying the following three Chinook sales: the Canadian nine aircraft buy in 1973, the British 33 aircraft buy in 1978 and the follow-on Spanish buy for three more aircraft in 1980. The differences in the three arrangements is in good part simply a function of the customer's leverage resulting from the size of each buy, but other considerations also enter into the picture; such



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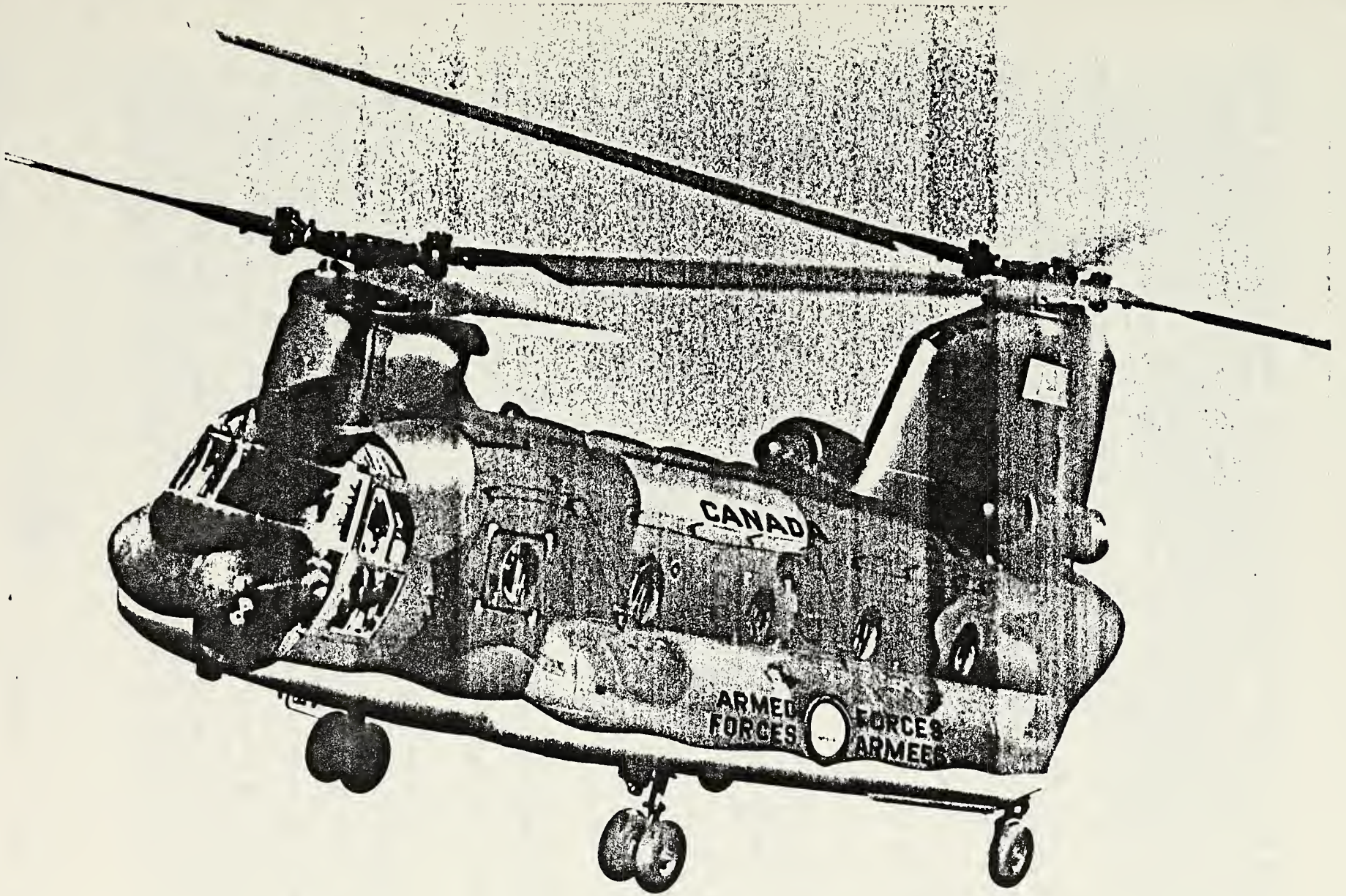
as existing industrial relationships, competitiveness, capabilities, and perceived interest of the purchasing nation's aerospace industry.

a. Canada's CH-147 Offset

In April 1973, Boeing Vertol and Sikorsky responded to requests for proposals from Canada's Department of Supply and Services (DSS) and the Department of Industry, Trade and Commerce (DITC) for eight medium lift helicopters and support equipment for the Canadian Armed Forces. Each U.S. firm provided dual proposals, one for the aircraft buy and one for compensatory work. The CH-47, to be designated the CH-147 in its Canadian variant, was selected over the CH-53 in July 1973.[109]

The eight aircraft buy was through FMS channels and came to $23,820,489. Delivery occurred between September 1974 and October 1975. After one of these eight helicopters crashed in a post-delivery ferry flight, the DSS contracted for a ninth Chinook but this time as a direct commercial sale, not FMS. The ninth Chinook cost $5.4 million and was delivered in April 1978.

In early 1950, just months after signing the North Atlantic Treaty, the Canadian government began a major reequipment program for its land forces which involved a surplusing of its older British equipment of World War II vintage and an adoption of newer equipment, primarily of U.S. origin. The surplused British equipment was distributed to Canada's European allies under the guidance of NATO's international staff, on a grant-aid basis.



Source: Boeing Canadian CH-147

As the new era of cold war called upon the social democracies to form a military alliance of sovereign nations, the members had to collectively summon up the resources to arm themselves. No easy task for an open society while still in a period of relative peace.

During the rapid build-up of the early 50's, the European members of NATO, with the exception of the U.K. received most of their equipment from the two North American members of the Alliance. As the Europeans were still rebuilding from the devastation of the war, their contribution at this time was primarily in the area of manpower. Therefore, sharing in the production side of the equation was not yet an issue, because the continental Europeans were not carrying a major share of the initial cost of equipping their forces. It was not until the late 1950's with full recovery from the war that the continental Europeans would assume the major share of the burden of defense procurement, at which time they too began to play a larger role in production.

Canada, on the other hand, had been paying for its own new equipment almost exclusively from domestic[110] or U.S. sources.[111]

This interest on the part of each national government in work sharing can be likened to the scenario in the U.S. where one of the major duties of all legislative representatives to the national government is to make sure that a percentage of the benefits of defense dollars and the related jobs trickle back down to their tax paying constituents back home. The addressing of such concerns are a part of the diffuse process by which coalitions are created for

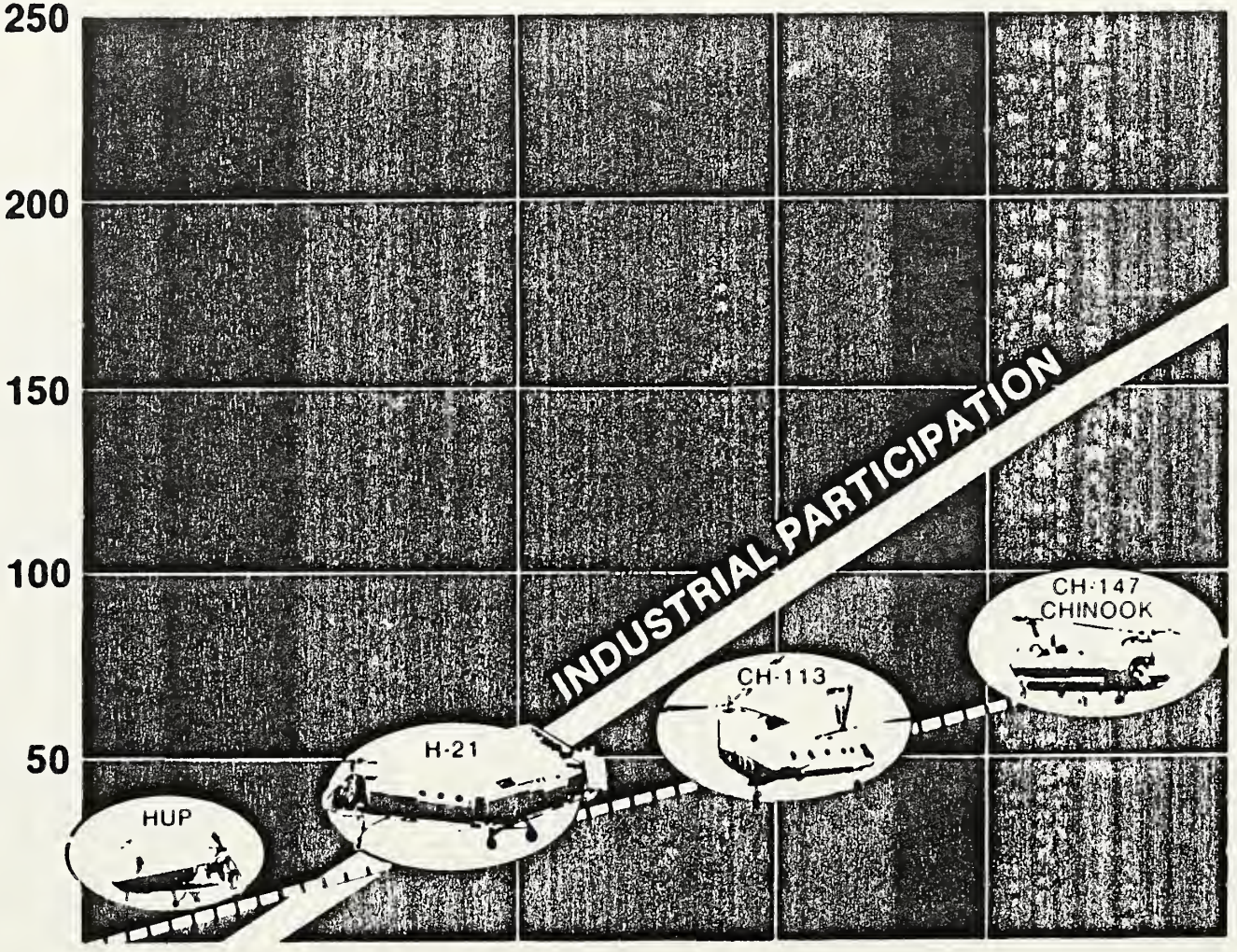
the passage of any given defense appropriations bills. This distribution and flow of the tax dollars to the folks back home involves not only the location of military bases and the placement of prime contracts, but legislation promoting a wide distribution of defense sub-contracts generally, and more specifically assuring that constituencies represented by depressed labor market regions, small businesses, and minority owned business get their share of the goodies. A bureaucracy and concommitant regulations naturally had to be set up for surveillance and enforcement of these work distribution policies on an on-going basis.

In much the same way Canadian parliamentarians designated the Department of Industry, Trade and Commerce (DITC) to be their watchdog to assure that their tax paying constituents would be getting back their share of expenditures. This was the origin of the DITC's function of 'qualifying' foreign (almost exclusively U.S.) defense contractors. The U.S. contractors ran the risk of being 'disqualified' for doing business in Canada, unless they could demonstrate a good offset history.

As with other U.S. defense contractors, when Canadian purchases built up during the 1950's, the DITC progressively pressured Piaseki/Vertol into placing work in Canada. Consequently Piaseki began in the mid-50's to ensure that their sub-contractor base was expanded to include firms north of the border. Moreover a subsidiary was setup in Arnprior, Ontario. As part of this effort, Piaseki, since renamed Vertol, began tracking its subcontracted work placed in Canada in 1959.[112]

31 YEARS . . .

• INDUSTRIAL PARTICIPATION
• GOVERNMENT HELICOPTER PROCUREMENT



BOEING VERTOL COMPANY

As of June 30, 1981 the total contract award to Canadian firms by the Vertol Division of Boeing alone (acquired by Boeing in 1960), had come to 112,199,091. The Vertol Division continues to track its Canadian work separately and reports to the Canadian DITC and DSS annually. This is due to the practice of DITC which considers the work placement figures for each division of a firm, i.e., company wide figures are not considered for purposes of qualification, only divisional. In March 1974 Boeing Vertol upgraded its on-going Canadian supplier arrangement, ratifying it in the form of the Boeing Vertol Company Long-Term Canadian Supplier Relationship Program.[113]

As we will see with the much larger CP-140 and CF-18 programs later in this chapter, Canada will apply stricter offset formulas for more visible programs where expenditures begin to approach the one billion dollar bench-mark (CP-140 maritime patrol aircraft), or far surpass it (CF-18 fighter).

For the Chinook purchase the DITC asked for projections of work to be placed in Canada over the 1973 to 1980 time frame. The Boeing Vertol proposal for compensatory work estimated the value of contracts that would be placed with Canadian firms if particular projected programs came through, and if Canadian firms were competitive in price, delivery and quality. The proposal basically affirmed that Boeing Vertol had been tapping Canadian suppliers for almost twenty years and would continue to do so.

As it was, some of the projected Boeing Vertol programs such as HLH, UTTAS, and the Rail Car never panned out, but various CH-46 Sea Knight and CH-47 Chinook improvement programs did better than expected.

Projections of work to be placed, and work actually placed, were as follows over the eight year period:

	Projections	Actuals[114]
1973	No Projection	$7,720,643
1974	$ 942,000	6,048,002
1975	3,782,000	5,476,811
1976	6,069,000	2,540,774
1977	8,032,000	3,074,982
1978	7,352,000	7,798,430
1979	4,460,000	5,585,190
1980	3,450,000	9,500,367
1981	No Projection	8,500,803

As the above figures indicate the mid 1976 to mid 1977 period was a particularly bad year with the cancellation of the HLH program by the U.S. Congress. Simulataneously the Rail Car program started to go sour. The worsening situation required Steve Tremper, Vice President Boeing of Canada, to send a letter to the DITC amending the original projections. It stated that in light of business losses that Vertol would not be able to meet its projections for the next several years. Vertol work placed in Canada did pick up almost immediately, however. In any event Vertol never received a reponse to the letter or heard anything more on the subject.[115]

The following are the most recent major programs at Boeing Vertol and Boeing of Canada Limited, Arnprior Division, involving industrial participation by Canadian vendors and Boeing of Canada Ltd.

CH-46E Program (USN)—Boeing Vertol developed, qualified and is manufacturing kits for this program. The planned two hundred seventy-three (273) modification kits have been ordered over the past several years. A Canadian firm, SPAR, received $757,000 in orders for auxiliary gear boxes during the July 1, 1980 to June 30, 1981 reporting year.

CH-46 Safety, Reliability, Maintainability SR&M Program (USN)—This is a new USN program to extend the life of 368 CH-46's until the mid 1990's. This involves the redesign, test and production of new components for the airframe, landing gear, electrical and hydraulic system. Menasco has received an $80,000 initial order for soft tooling and parts for the piston assembly for the new landing gear. SPAR Aerospace has received an initial order of $544,000 for new gears for mix box transmissions.

CH-113-113A Fiberglass Blade Program—VICOM, a new Boeing Vertol supplier, has received an $345,925 initial order for pitch housings for the fiberglass rotor blades for CH-113, CH-113A and the Swedish HKP-4's.[116]

CH-47 Chinook Production Program—The Chinook continues in production with over 800 Chinooks of all models built. MENASCO is the supplier of landing gear for new helicopters and spares. They have received authorization to

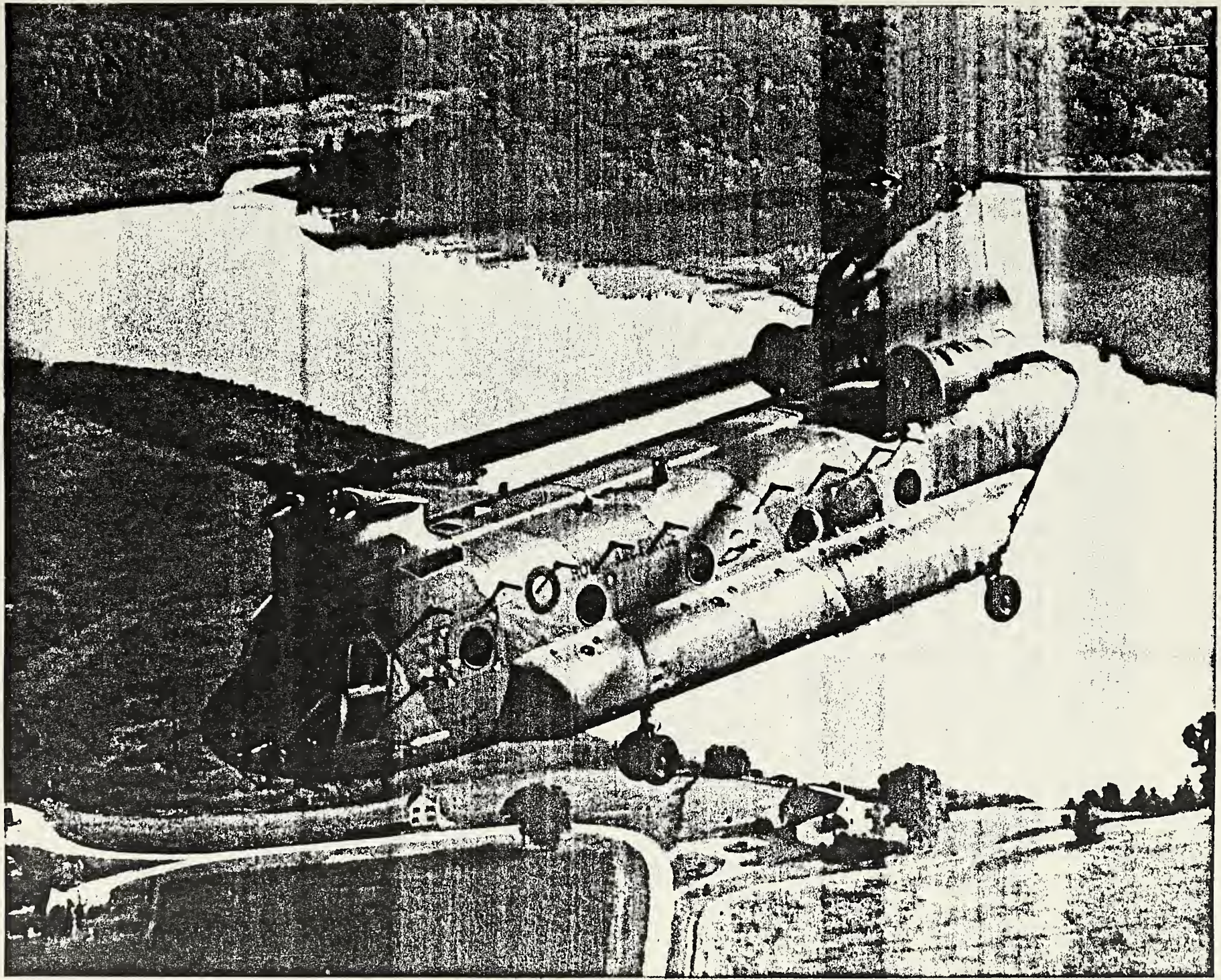
proceed at a value of approximately $2,611,000 for landing gears for this reporting period. Boeing Vertol is producing Chinooks (Model 234) for the civil market as well as for government customers.

CH-47D Modernization Program (USA)—Under a U.S. Army development contract, three CH-47's which originally were delivered to the U.S. Army in Model A,

B and C configurations have been rebuilt and modernized into a common CH-47D version. These three CH-47D prototypes have been flight tested and field evaluated. Production contracts to begin modernizing 361 of the earlier CH-47's to the D configuration have been received. Litton is subcontracting the aft transmission housing tooling and castings to Haley Industries in Canada. MENASCO has received initial orders for the refurbishment of CH-47D landing gears.

Boeing of Canada Limited - Fabrication Division—This modern plant in Winnipeg manufactures fiberglass parts for Boeing Vertol's helicopters as well as parts for transport aircraft in Seattle. Boeing Vertol placed $540,237 in orders during this reporting period.[117]

Boeing of Canada Limited - Arnprior Division[118]—The Division acquired the rights from Delco (General Motors) for production of helicopter rotor lag dampers. Over 3,100 damper kits have been delivered primarily to the U.S. Navy. Orders for a substantial additional quantity of damper kits are



Source: Boeing RAF CH-47C-414

currently in process of being authorized by the U.S. Navy. Annual business for damper kits and parts is approximately $400,000. These rotor lag dampers are used by the U.S. Navy, Canada, Sweden and Columbia Helicopters, a commercial operator in the United States. Since the life of these several hundred helicopters has been extended into the 1990's, continuing damper business is expected.[119]

b. The British Offset

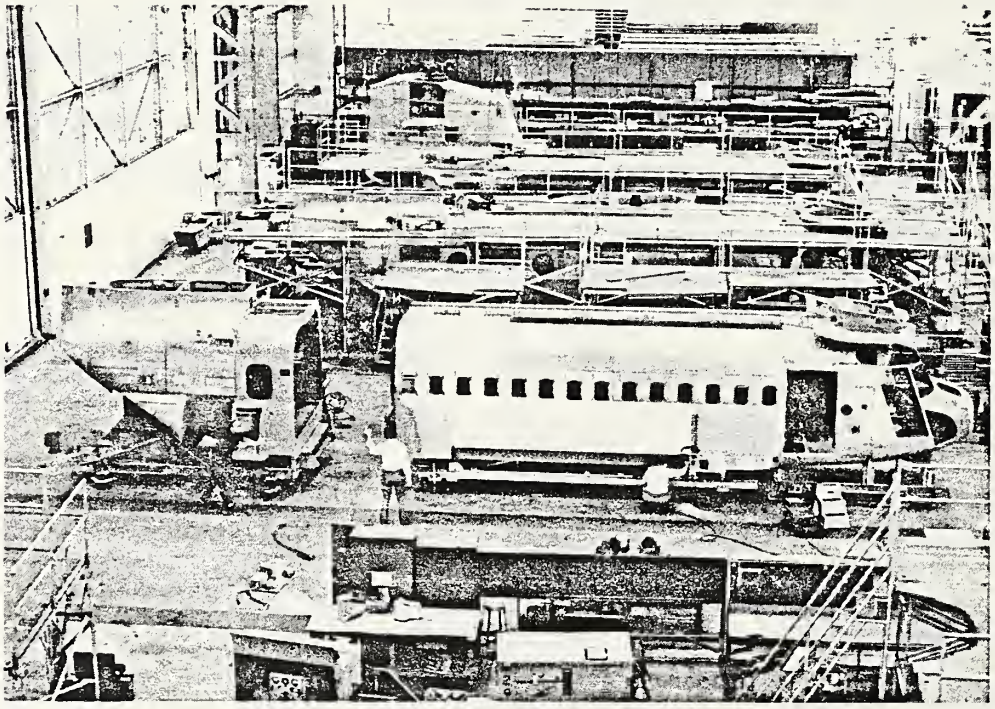
In January, 1978, the British Defense Ministry decided to go ahead with the purchase of 30 Boeing Vertol HC MK1 CH-47C-414 Chinook medium lift helicopters for the RAF. In October, 1978, this order was increased to 33 aircraft.

Deliveries to the RAF began in August, 1980, and are to continue through 1981. This 33 aircraft order represented the largest export contract in the division's history, worth a total of $242,250,000.

The initial British order of CH-47's, in 1977, was to have been for seven Chinooks. This increased, however, to 30 following an increase in the British defense budget as part of the UK's efforts to increase its support of its NATO forces, as well as the cancellation or cutback of several other programs. This order represented a major increase in the size of the medium lift helicopter force which will be operated by the RAF in support of the British Army of the Rhine (BAOR).[120]

The Chinook (the B model) had previously been selected by the British back in 1966 over the Sikorsky CH-53, but the 15 aircraft order had been cancelled. The original plan had been for the British and Germans to make a joint buy of either the Boeing Vertol CH-47 or the Sikorsky CH-53. This was to also involve some sort of cooperative production arrangement. It being no easy task to coordinate two national acquisition processes, the joint program collapsed when the FRG delayed its final decision. The UK went ahead unilaterally for several years with the planned Chinook buy before it was cancelled in 1970. In the meantime, the German program also finally went ahead, but on firmer footing, with its purchase of 133 CH-53's (later reduced to 110) that involved assembly by German industry and a limited degree of licensed production, collectively amounting to some 50% of the total cost of the buy. (Mode #1, treated in Chapter 6.)

Having learned well from its previous experience, i.e., of the vulnerability of a program involving no offset, Boeing Vertol offered, in December 1977, to undertake the placing, or causing to be placed by its subcontractors, orders for work with UK firms amounting to at least 20% of the total delivered price of the aircraft. However, unlike the Canadian offset which simply involved annual projections of an on-going flow of work passed to Canadian suppliers, the British offset reflected a commitment to redirect work through a broadening of Boeing Vertol's supplier base outside of North America. These industry provided internal and external offset orders were to be placed within a period of ten years starting from February 1, 1978.



First Commercial Chinook Fuselage Spliced

Fuselage splicing of the first Boeing 234 Commercial Chinook 44-passenger helicopter took place at Boeing Vertol's main facility recently. Boeing now holds seven orders and five options for the Commercial Chinook, after negotiations between the company and Bristow Helicopters for five options were terminated. First flight is planned for July.

An offset value of 30% was finally agreed to in January, 1978. This broke down into a firm commitment of 25% amounting to $60,562,500 in work, and another 5% involving best efforts towards the placing of $12,112,500 in work with British industry for a total target value of $72,675,000. The 5% best efforts portion of the offset was a last minute add-on to make up for the collapse of the technology transfer portion of the offset, one involving the composite rotary blades and Britain's Westland Helicopters.

As of December 19, 1980 the offset agreement had progressed smoothly with the dollar value of tenders submitted to U.K. suppliers by Vertol and AVCO Lycoming amounting to $82,100,974 and broken down as follows:

Firm purchase orders placed	
Vertol	$21,114,359
Avco Lycoming	$ 5,923,982
Litton Precision	$ 41,520
	$27,079,861
Tenders in process	
Vertol	$14,523,200
Avco Lycoming	$10,658,666
	$25,181,860
Non-successful tenders	
Vertol	$10,327,463
Avco Lycoming	$19,511,790
	$29,839,253

The components and materials purchased have been for incorporation into not only the 33 RAF Chinooks, but recent Chinook orders from other customers as well, including the U.S. Army, British Airways (for the commercial derivative) and the Australian Air Force.

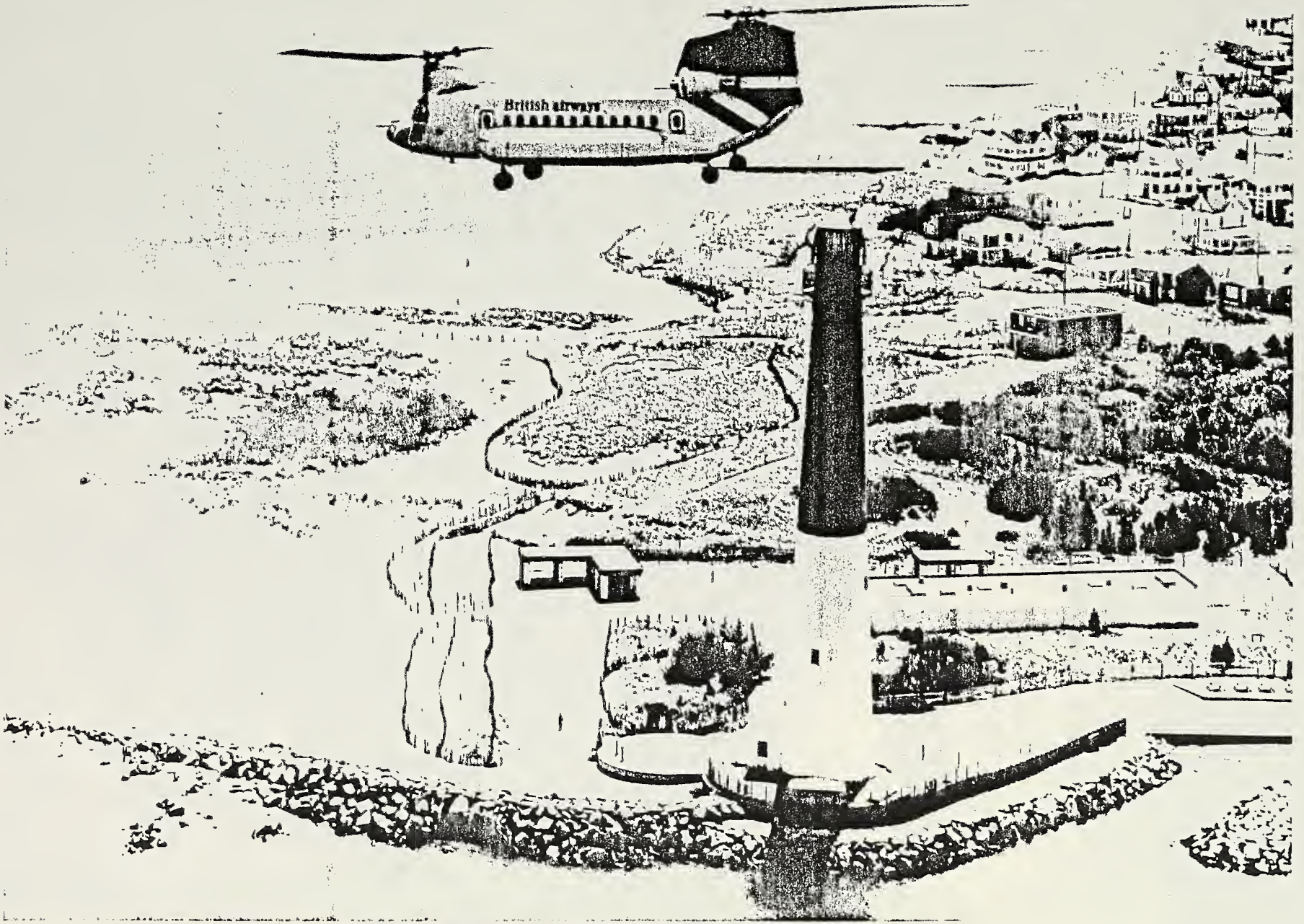
As is often the case, the British avionics industry will also benefit from government designated procurement (not considered an offset), related to the British CH-47 purchase. Marconi Avionics was awarded an initial 1.5 million pounds contract in early 1979 for advanced radio navigation and communications systems to outfit the Boeing Vertol CH-47's. Among the most advanced of their kind in the world according to a Marconi Avionics spokesman, the systems are the ARC 340 VHF/FM Comms and Homing System, the AD120 VHF/AM Comms system, the AD380 "push button" Automatic Direction Finder, the AD2770 TACAN navigation system, and the AD27733 Interface Unit, specially designed by Marconi

Avionics in conjunction with Boeing Vertol, to interface the TACAN with existing aircraft instrumentation.[121]

As of the end of 1980, five British firms had received orders from Boeing Vertol in excess of $1,000,000, collectively totaling $16.1 M:

British Hovercraft Corp Ltd. - for fuel pod assemblies, wave and flotation tests for the US Army and commercial CH-47s, and spares (for production of the fuel pods Boeing Vertol had to work with the U.S. Army to obtain approval of shifting the sole source overseas and also the sending over of U.S. government owned special tooling to Hovercraft on the Isle of Wight).

FPT Industries - for main and auxiliary fuel cells, fuel cell assemblies for RAF and commercial CH-47s and spares;



Source: Boeing British Airways Model 234

LUCAS - Aerospace Ltd. - for generators, generator control units, transformers, drive shafts for US Army, RAF, and commercial CH-47s, and spares;

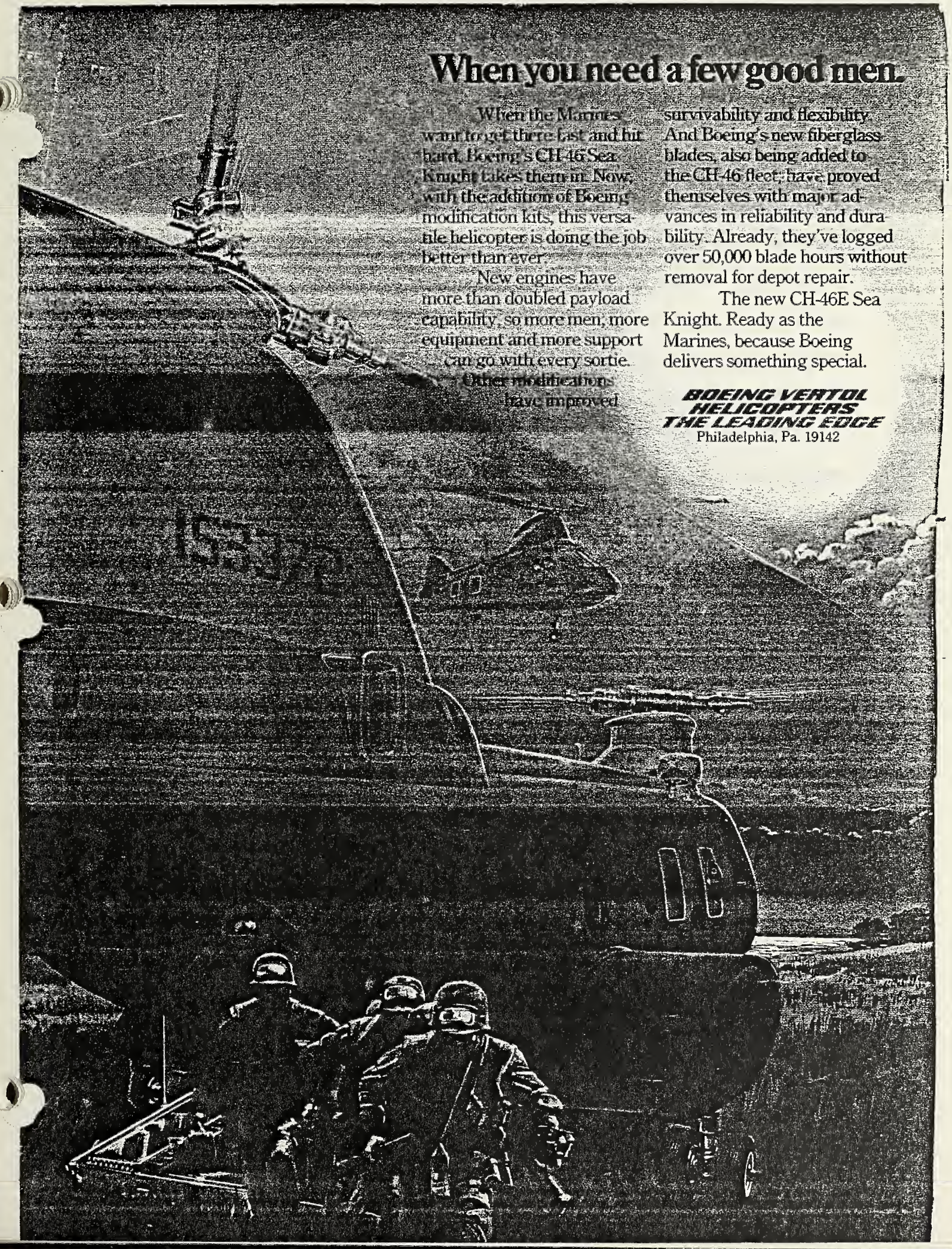
Metallic Components Ltd. - for interiors for commercial version of CH-47, and;

Westland Helicopters - for vertical and horizontal hinge pins for RAF, US Army, and commercial CH-47s.

Boeing Vertol had placed orders with another 32 British firms for a total of around $5 million ranging individually from several hundred dollars in value up to around $700,000 and including such items as adapters, supports, connectors, attitude indicators, paint and so forth.

In order for Vertol to ensure fulfillment of the terms agreed to in its contract with the British, the proper organization had to be setup.

For this offset program a new office was created and given a special charter. Mr. John Mc Lean, who reported to Vertol's Director of Materiel, became "Manager Division Offset." Mr. Mc Lean was given authority commensurate with the task, by receiving a special charter to go to whomever was required in Vertol to support fulfillment of the offset commitment. This authorized him to go all the way to Vertol's president if need be.[122]



When you need a few good men.

When the Marines want to get there fast and hit hard, Boeing's CH-46 Sea Knight takes them in. Now, with the addition of Boeing modification kits, this versatile helicopter is doing the job better than ever.

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As of December 1982 (with a Spanish offset program having been added to his functions in the interim), Mr. Mc Lean figures that the offset segment of his job took about 60% of his time. Mr. Mc Lean's expanded functions include the organizing of vendor survey's, e.g., checking out the firms capabilities in the areas of machining, manufacturing, quality control systems, financial soundness and management); coordinating contacts by British and Spanish firms with the appropriate in-house people, such as Materiel, Quality, Operations, PMO, Contract Administration and Engineering; working with the appropriate embassies in Washington, D.C., and New York and Philadelphia consulates on customs, shipping and security problems; working with outside consultants in London and Madrid; plus general public relations functions for the offset program.[123]

Mr. Mc Lean reports to the British MOD bi-annually on the status of the program. The December 1982 reports showed that the offset figure for purchase orders placed by Boeing Vertol Materiel with over 50 British firms had come to a total of $49 million. This puts the offset program well ahead of schedule. Not only were those British firms receiving orders competitive in price and quality, but the majority were also ahead of schedule. Mr. Mc Lean feels that over the long-term the program will have a multiplier effect, providing the British aerospace industry another important entrée to the U.S. market. "The relationships established have placed British industry in a strong position to compete for similar business in the future, both with Vertol and other divisions of Boeing, plus elsewhere in the U.S. aerospace industry."[124]

Both Boeing Vertol and the British MOD have been very satisfied with progress to date in implementation of the program.

c. The Spanish Offset

For the Spanish CH-47C order several years later, yet another sort of offset arrangement was utilized. Following negotiations occurring over the first four months of 1980, the Spanish government and Boeing Vertol signed a $28,000,000 contract for three additional Chinooks, on November 14, 1980. The aircraft were delivered in May and June 1982 and will bring the Spanish Chinook force up to 12 (one of the earlier Chinooks had crashed).

The Chinook (Model 414) sale was accompanied by Boeing Vertol's agreeing to an industrial compensation program wherein it would issue quotation requests over the seven year period following signature of the contract for articles or services in a quantity equivalent to 20% of contract price (5.6M).[125] Even once this level is achieved, Boeing Vertol has agreed to continue issuing requests until the contracted price attains the 20% level (5.6M) figure, whichever is earlier.[126] Note that this objective concerns a certain value of RFQs issued, not work actually placed. Mr. Mclean's office is also responsible for implementing this newer offset program as well, and has expanded its working relationships accordingly to include the Spanish MOD, outside consultants in Madrid, Spanish industrial associations, and the Spanish Embassy and consulate.



Source: Boeing Spa. CH-47C

While it is preferable that the industrial compensation relate to the aerospace segment of Spanish Industry, it may also include other commodities such as items and materials for the maintenance, repair and overhaul of Supplier's plant and facilities. Additionally, it may include items or services solicited by (1) Supplier, (2) its subcontractors, (3) others under license to them and (4) their lower tier subcontractors and licensees.

Following a forecast of its future procurement requirements Boeing Vertol agreed to conduct a survey within four months of the signature of the contract to identify a list of potential Spanish aerospace industry sources. Within seven months of the date of contract signature, the suppliers agreed to tour the facilities of the candidate sources with a survey team while also reviewing its procurement practices with potential sources. For future procurement requirements, the U.S. contractor will thereafter solicit proposals from, in addition to its regular sources, those Spanish firms that have been qualified.

Contracts are to be awarded to successful bidders on a standard competitive basis. The Boeing Vertol commitment is an objective, not a contractual guarantee. However, there is a penalty for non-compliance of $50,000.

According to Vertol's cognizant manager, Mr. John Mclean, one of the major potential candidates for procurement from Spain explored during 1981 involved machine tools. Boeing Vertol was interested in what Spanish industry had to offer. However, concerns over company-wide software commonality (i.e., a lack

of interchangeability) plus the maintenance impact of reliance on an undeveloped service network (i.e., greater down time), prevented this from ever panning out.[127]

6. The Belgian-Ford Armored Vehicle Buy

In July, 1979, the Belgian government selected the FMC M113A1 armored personnel carrier and the FMC AIFV armored infantry fighting vehicle over competing French equipment. This involved a buy of 525 M113A1's and 514 AIFV's for a total contract value of 15.6 billion Belgian Francs ($520 million).

Unlike the much larger Italian Army M113 buy in 1962, the size of the Belgian buy did not warrant a license production program.[128] Instead FMC is providing a 100% offset for the Belgian purchase. It was expected that the contracts would be finalized by November but several problems, including the implementation the offset agreement, had apparently delayed signing of the definitive contract. The 100% offset is broken down such that 70 percent of the total compensation package would be in the form of direct (or internal) offset orders placed in Belgian for work on the vehicles, with the remaining 30 percent in indirect (or exernal) offset orders to Belgian industry. Moreover, before the definitive contract was signed, three-quarters of the total offset package was to be put under contract.

E. THE DUTCH LEOPARD 2 ORDER (1979)

The Dutch government announced on March 2, 1979 that it had selected the Leopard 2 of the FRG's Krauss-Maffei over the M-1 of the U.S. Chrysler Corp. These two tanks had resulted from the collapse in 1970 of the joint US-FRG MBT-70 tank development program covered in Chapter 10 (Mode #5). The Leopard 2 will replace the Netherland's obsolete British Centurion and French AMX-13 tanks.

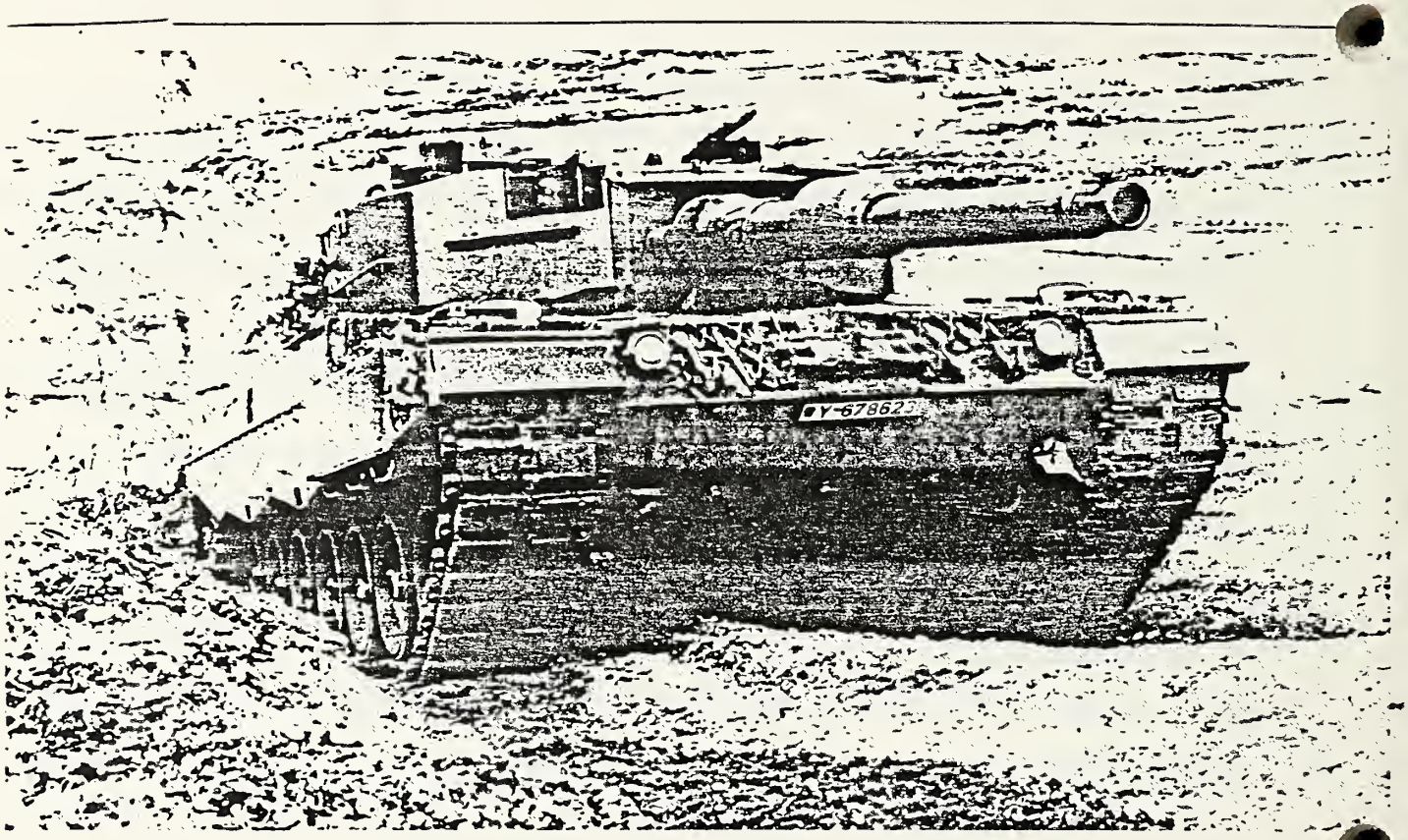
1. The Competition

As of September 1978 the Krauss-Maffei had been offering to farm out work equal to 80% of the price tag to Dutch firms in internal and external offsets, while retaining assembly in the FRG.

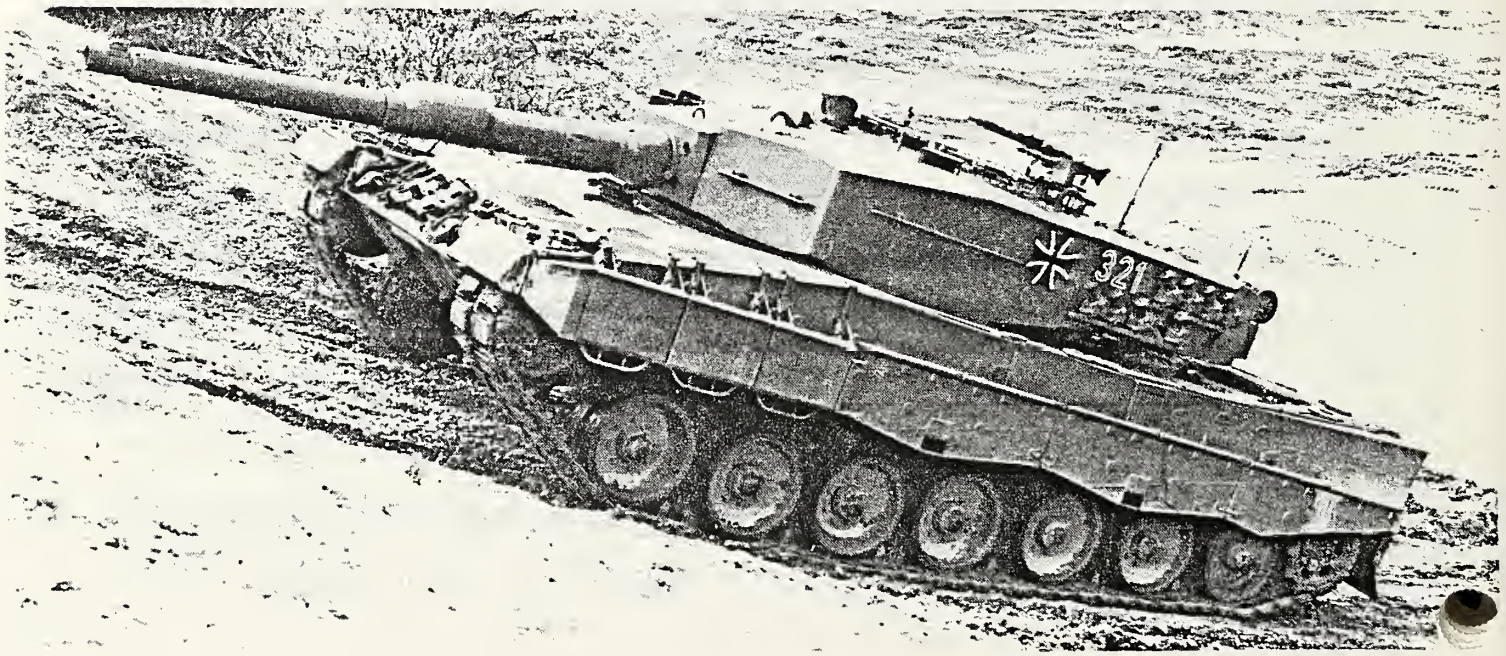
Chrysler had been offering, back in September, to turn over 55% of the work on a prospective M-1 order to Dutch companies. Some of the controls were to be made by Philips and the turrets and guns were to be manufactured by the depressed Dutch shipbuilding industry. Truck-manufacturer DAF would have assembled the M-1's. As one additional carrot, the U.S. government had been dangling the maintenance contract for U.S. tanks with U.S. forces stationed in Europe in front of Rotterdam Drydock Co., but this couldn't involve any guarantees.

In September, 1978, a Dutch Economics Ministry official, William Melis had been quoted as saying "You cannot say anyone has an advantage or disadvantage at this point. What interests us is the best deal for Dutch industry."[129]

Leopard 2



Source: Military Technology



Source: NATO's Fifteen Nations

At the time of the announcement of the decision in favor of the Leopard 2 in March 1979, Dutch Defense Minister Willem Scholten said the Leopard 2's 120-mm gun was a better match for Warsaw Pact forces than the M-1's 105-mm cannon (though by 1984 XM-1 production is expected to involve the replacement of the existing gun with the German gun). Scholten also said that the German tank offered greater possibilities for standardization within NATO's Northern Army Group, and for logistical cooperation with German forces.

The Dutch decision was expected to affect those of other nations. Norway and Denmark, for example plan to buy a total of 250 new generation tanks in the near future. The Dutch sale was also to be the first foreign purchase of either tank and was expected to give the winner a jump on the market for new-generation tanks.

Krauss-Maffei was already the largest tank manufacturer in NATO, its Leopard I having been adopted by the majority of NATO's armies, including the Netherlands, over competing American, British, and French models.

And so the offset influenced selection of foreign weapon systems continues, and along with it the ever increasing need of selling firms and their governments to deal with this Mode of industrial collaboration.

2. The Offset Program

Under the Dutch-German agreement, the Netherlands will purchase 445 Leopards for a total of $1.22 billion with up to 59% participation in production by

Dutch industry. The remaining 41+%, up to the 100% total, will be covered by additional industry provided external offsets.

Unlike the earlier Leopard I sale to The Netherlands, this sale involved no German government provided offsets. The 100% offset included Krauss-Maffei's assuring the participation of Dutch industry in not just the Dutch but also the German order for 1,800 Leopard 2 battle tanks. This participation in the German procured tanks' production was in good part a function of the Dutch order coming at an early stage of the production cycle. Industrial and technological benefits to Dutch industry and the resulting transfer of know-how are expected to come from:

- armor steel processing;
- engine production;
- transmission production;
- electrical components;
- electronic components;
- optical components;
- hydraulic and mechanical components;
- ammunition production, and;
- general and vehicle construction.

3. Krauss-Maffei's Offset Philosophy and Expertise

Wolfgang Raether, Member of the Krauss-Maffei Board of Directors responded to querying by the periodical, NATO's Fifteen Nations, shortly after the Dutch

decision had been announced. To the interviewer's question: "Are you generally offering a compensation package for exporting the tank?"

Raether responded:

> "Of course, no country would negotiate such a contract without such agreements. We have established a reputation for fulfilling our contractual obligations with regard to compensation. We have our own specialized staff which is experienced in this field. Without the offer of co- production and/or compensation no order of such a size would be realized."[130]

In an earlier interview with NATO's Fifteen Nations, one that appeared in its October-November 1978 issue, Claus-Detlef Lehmann, Commercial Managing Director of Krauss-Maffei's Ordnance Division commented on the general structuring of such bi-lateral industrial offset arrangements as those accompanying the sales of the Leopard 1 and 2. Krauss-Maffei stands out as easily the most experienced of firms in this area.

> For offset orders, the purchases in question need not technically correspond to the weapon system to be purchased, they need not even be related to defense products. Both forms of economical compensation raise considerable problems for the supplying industry. In the case of an offset agreement, the problems mainly concern:
>
> - the time span in the course of which the supplying industry has to fulfill its offset obligations;
> - the selection of goods the purchasing country will accept as offset;
> - the compatibility of the customer country's industry; and,
> - the volume to be compensated.
>
> It is in the interest of the purchaser to reach, if possible, 100% compensation for the foreign currency drain resulting from the purchase. In addition, the government of the buying country will possibly include only those products into the list of offset

goods, whose export entails difficulties and, as a result, employment problems for the buying country. In the question of duration and schedule of the offset agreement, the importing country will probably stipulate a short time span in order to conduct a fast flow-back of the foreign currency temporarily lost.

The maximum demands of one contracting party cannot, of course, provide the basis for a realistic offset agreement. This requires an analysis of the flow of goods between the buying country and the producing country, which then serves as the basis for the range of offset goods to be agreed upon. The range of offset goods included should be as broad as possible and should also contain products for which the buying country is already qualified to export, thus proving its compatibility in this field. The more the product range is limited, the longer must be the time available for the arrangement of offset commissions, and the lower will be the percentage in the total offset volume.

In working out the offset agreement, the so-called "long-term effect" must also be considered. This phenomenon arises from the fact that business relations resulting from an offset agreement, which at first were regarded as a "forced" measure, in many cases surpass in volume and time the provisions of the original agreement. Since this effect comes to light only after an offset agreement has been fulfilled, it is placed in question by the contractor during negotiations, and often not taken into consideration.[131]

Lehmann offered further incites as to the organizational prerequisites to operating in this Mode, and the long-term significance of conducting business in this manner.

While an offset contract is being fulfilled, the industrial company under obligation must have available the various prerequisites for personnel and organization. Experience has shown that for the fulfillment of large-volume offset contracts a separate organization must be established, mainly because conventional company functions, such as sale and purchase, are not akin to procedures in offset operations. The offset represents a very special field of industrial activity. Personnel of a mechanical engineering company must, for instance, look after the import of wooden products or basic materials.

Sometimes, the opinion is voiced that such a compensation is actually "medieval bartering." Besides the fact that this is not correct, since the buying country pays in currency for the weapons systems, the industrial suppliers must acknowledge the political and economical considerations which in the framework of an offset

agreement constitute compensation for the substantial foreign currency transfer. Difficult as it may sometimes be, this must be accepted by industry. In the future, it will be quite impossible to sell large-scale weapon systems to other industrial states without accepting certain offset obligations.[132]

F. THE CANADIAN/LOCKHEED CP-140

1. Introduction

The 18 CP-140 Aurora aircraft, delivered between May, 1980 and March, 1981, are at the center of one of the larger and more complex offset arrangements entered into by a U.S. firm; one totaling almost $1 billion in work over an 18-year period for Canadian industry. The offset represents an amount roughly equal to the total value of the 18 aircraft contract. The 18 CP-140's will fill the Canadian requirement for a Long Range Patrol Aircraft (LRPA), replacing 26 Canadair Argus aircraft that have been handling Canada's maritime patrol duties since the late 50's.[133]

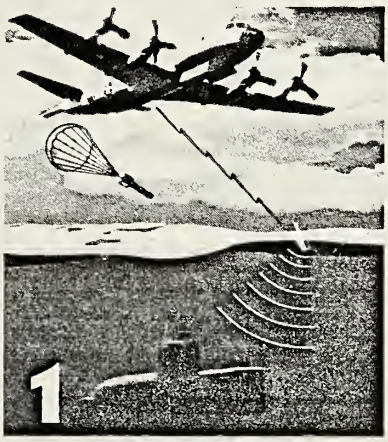
The Canadian Forces/Lockheed CP-140 is a special derivative of the U.S. Navy/ Lockheed P-3C Orion designed to Canada's particular requirements, one that incorporates avionics equipment from the newer USN/Lockheed S-3A Viking as well as a number of Canadian firms.

The contract is a direct Canadian government - Lockheed one for which the Canadian Forces has a detachment of approximately 130 persons assigned to Lockheed's Burbank, California, facility involved in administering contract activity. The contracting government agency, Canadian Dept. of Supply and Services, has an additional 15 persons assigned to the program at Burbank.

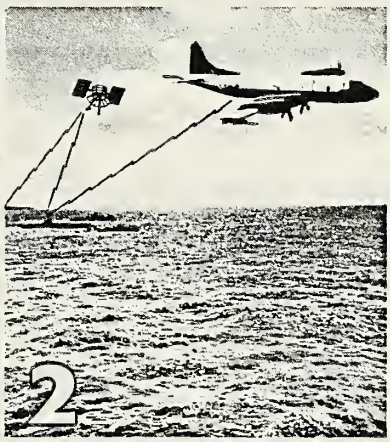
The CP-140 will perform a variety of patrol activities, including shipping and fisheries surveillance along Canadian waters, subsurface defense and search

When defense dollars get squeezed, you need a 7-way weapon system.

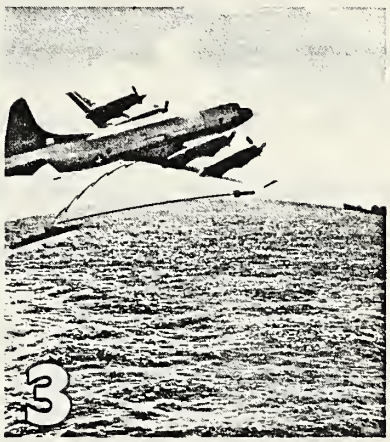
That's the P-3C Orion,
the biggest 1% in the Navy's budget.



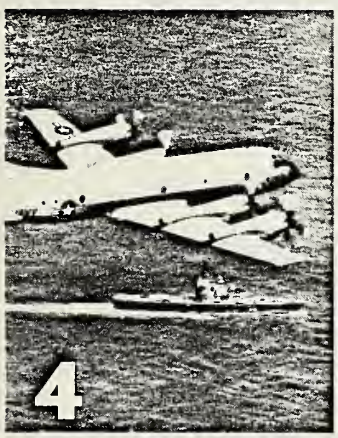
Antisubmarine warfare



Command, control, and communication



Over-the-horizon targeting



Surveillance



Convoy protection



Antisurface warfare



Mine laying

The Free World now faces a double threat to freedom of the seas.

A potentially hostile blue-water fleet of awesome power and diverse capabilities must be deterred within the limits of a tight defense budget.

The P-3C Orion evens the odds. The P-3C is a force multiplier—a weapon system of many missions, with the built-in flexibility to help counter the growing threat to freedom of the seas.

It handles surveillance and convoy protection; mine laying and over-the-horizon targeting; antisurface warfare and antisubmarine warfare; command, control, and communication.

And it does it all while taking only 1% of the U.S. Navy's procurement budget.

The U.S. Navy has a huge task in assuring freedom of the seas. The P-3C is its most flexible airborne weapon system in achieving that end.

Lockheed P-3C Orion
Leadership in Technology

and rescue missions. Patrol of Canadian waters, Canada's coastline being one of the longest in the world, plus the monitoring of Canada's vast Arctic area, forms an important part of the country's Defense effort.[134]

2. The Competition

The competition for Canada's LRPA requirement involved initially, in addition to the Lockheed entry, Boeing's ASW version of the 707, the McDonnell Douglas ASW version of the DC-8, Britain's Hawker Siddeley Nimrod ASW aircraft (using the Comet airframe), the Breguet Atlantic (developed and produced by a French led consortium including German, Dutch, Belgian and Italian firms) and Canadair's updated version of the Argus. The two finalists in 1973 were Lockheed and Boeing.

The Boeing system offered to Canada equal capability with fewer aircraft, but at several hundred million more in initial procurement costs than the Lockheed aircraft. Though Lockheed had a natural advantage from the beginning due to its historic domination of the U.S. and allied maritime patrol aircraft markets with its P-2 Neptune, P-3 Orion, and S-3 Viking, the U.S. Navy was interested in supporting the competition in the interests of driving the price down for an allied government, as well as that of using it to promote the development of a more advanced maritime patrol aircraft.

In an attempt to counter the ASW version of the 707's handicap of greater uncertainty and a considerably higher price, Boeing put together one of the most extensive offset programs ever entered into by the company. In addition to sub-contracting to Canadian firms work on the LRPA aircraft itself, the

Boeing offer involved work on other existing Boeing programs, proposals for participating in the restructuring of the Canadian aircraft industry, and the identification of opportunities for Canada to participate in its upcoming new commercial air transport programs.

The firm content/offset package plus highly probable follow-on totaled $570 million which was equal to 70% of 25 airplane LRPA program dollars. More than 2,000 direct jobs per year were to be created through the 1970's totalling nearly 16,000 man/years of employment.

CANADIAN INVOLVEMENT	25 AIRPLANE BASELINE	21 AIRPLANE RECOMMENDATION
Firm & Probable	70%	82%
Firm, Probable & Possible	120%	140%

The three major elements of the Boeing Industrial Benefits Proposal were:

a. Series of three alternative actions, categorized by Boeing as "industry assistance," worth up to $5 million.

   - Long-standing offer to assume minority equity position in restructured Canadian Aerospace Industry.
   - Comprehensive two-phase management assistance/consulting program:

     Phase I: Prior to LRPA contract award, in-depth survey of canadian deHaviland by Boeing management team on a fee basis, (fee estimate $150,000).

     Phase II: Subsquent to LPRA Award, continued management assistance based on recommendations of earlier survey, principally oriented to the Canadair portion of restructured industry. Repayment would be on a contract-fee basis. (Equity in lieu of cash payment would be

considered.)

- Boeing would expand its support of the DHC-7 program on a contract fee basis with option of equity in lieu of cash.

b. Canadian Subcontract Work From Boeing and Boeing Vendors:

- LRPA Content

- Direct Canadian Participation	$ 59	MILLION
- Subcontracts & Offsets from U.S. LRPA Suppliers	$ 73	MILLION
- Canadian Content in 18-707 Aircraft	$ 7	MILLION
Total	$ 139	MILLION

- Existing Contracts, Follow-On, and Vendor Pledges

- Existing Subcontracts	$ 44	MILLION
- Follow-on To Above	$ 12	MILLION
- Vendor Pledges	$ 40	MILLION
Total	$ 96	MILLION

c. New subcontract bidding opportunities - Expected Business: $165 Million, With Potential of $800 Million.

NEW PROGRAM POSSIBILITIES	NEW BIDDING OPPORTUNITIES - EXISTING PROGRAMS
- 7X7	- Minuteman
- YC-14	- Hydrofoils
- Roland Missile	- SRAM
- Commercial Derivatives	- Airborne Command Post
	- Electronics
	- Other Goods & Services

Lockheed found itself having to meet this Boeing offset package with one of its own that was comparable in scope. In the end, Canada opted for an advanced version of an existing U.S. system with all the advantages of lower price, less risk and greater commonality with systems currently in the U.S. inventory, i.e., both the Orion and the Viking.[135] Though source selection was completed in 1973 funding problems held up contract award for several more years.

3. The Structure of the Lockheed Offset Package

The offset of $937.6 million to which Lockheed finally agreed under terms of the prime contract[136] was structured in the following manner:

- $414 million portion of the offset obligations are subject to penalties for non-compliance
  - 10% for the $213.2 million guaranteed for the period through 1981
  - 5% for the $201 million guaranteed for the period 1982 to 1993;



Cost effective troubleshooter.

It's the P-3C Orion, and it offers a lot of advantages both to people who must manage budgets and to people who must cope with potential trouble.

To begin with budgets, the P-3C Orion takes less than 1% of the U.S. Navy's fiscal '81 budget. Yet it has been described as the Free World's premier land-based maritime patrol aircraft... without equal in its antisubmarine warfare and ocean surveillance capabilities... essential to the operation of CV battle groups.

Its mission flexibility is a key advantage in a troubled world. It can be deployed rapidly to remote areas. There its unmatched combination of range and acoustic, infrared and electronic detection systems enables it to keep emerging situations under a close surveillance impossible with any other aircraft. And as more and more squadrons are armed with Harpoon, more and more potential troublemakers will think twice about the presence of the P-3C.

The P-3C also brings trouble watchers the great advantage of self-sufficiency. It operates effectively from austere fields. And it has one of the Navy's highest operational readiness records.

The P-3C Orion. From a viewpoint of both procurement and operations, it's unquestionably one of America's biggest defense bargains.

Lockheed P-3C Orion

- $168 million of work to be placed in Canada which is not subject to penalties is based on 150 ship sets of CP 140/P-3C components;

- $350 million of work for the 1981-95 period which involves opportunities to bid on Lockheed subcontracts for new activities;

- Lockheed also undertook to assist Canadair Ltd., and de Haviland Aircraft of Canada in marketing certain of their products throughout the world.[137]

The $414 million penalty portion involved obligations of both Lockheed and 30 of its suppliers. The $213.2 million with a 10% guarantee was spread between them so that Lockheed guaranteed $94 million, and its suppliers $119 million. For the $201 million with a 5% guarantee, the split was Lockheed $135 million, and its suppliers $66 million.[138]

The suppliers are obligated as a condition of their purchase agreements with Lockheed to buy in Canada parts or equipment destined for this program or its equivalents. Any parts purchased in the U. S. by Canadian suppliers on the program are not included in the offset arrangement.[139]

In one case, a CP-140 supplier is building a facility in Canada for the program. The supplier, Sperry Rand Univac, which supplies the aircraft's AYK-10 central digital computer is manufacturing in Winnipeg digital magnetic

tape units. These store and load software program data for the central computer.[140]

In another case, the Guidance and Control Systems Div. of Litton Industries will provide the twin LN-33 inertial navigators for each CP-140 from its plant in Woodland Hills, Calif. Since small number of navigators involved in the program did not justify the expense of shifting production to the company's Litton Systems Canada Division in Toronto, Litton transferred other work to the Canadian division at a value matching that of the inertial systems.[141]

The $168 million associated with the manufacture of 150 P-3C structures includes the 18 aircraft Canadian order as well as future P-3 sales. Should the actual number exceed 150, the Canadians will be recipients of more than the promised $168 million in structures business. If the number falls below 150, this offset figure will not be met—to no financial disadvantage to Lockheed.[142]

Since the $168 million portion of offset is a function of future P-3 sales there is no penalty involved. There is also no penalty for failure to reach the $350 million portion. The CP-140 U.S. suppliers are not involved in either of these parts of the offset.

The five major Canadian firms involved are:

- Canadair, Ltd., Montreal, Quebec which is handling the largest share of production in Canada of CP-140/P-3 assemblies, including the outer

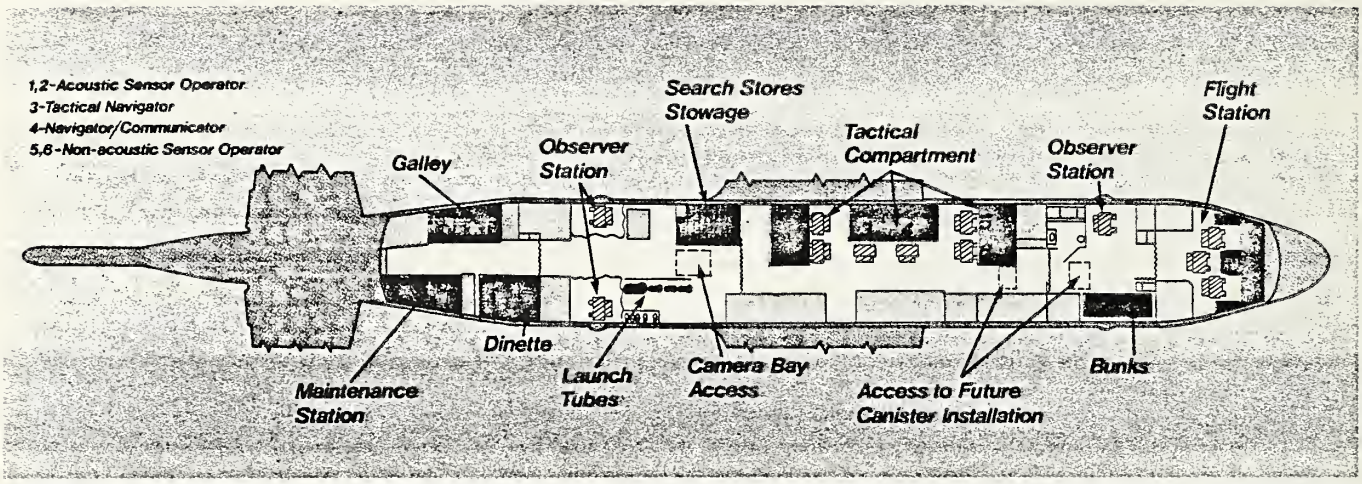
and center wing box, aft fuselage, nose and aft radome, machined parts, wing tips and search stores rack.

- Enheat, Ltd., of Amherst, Nova Scotia, is building the rudder, weapon bay doors and elevator.
- Fleet Industries of Ft. Erie, Ontario, is producing the aircraft flight station.
- Bristol Aerospace of Winnipeg, Manitoba, assembled wing components, and;
- IMP Aerospace, Ltd., Dartmouth, Nova Scotia has the contract for the aircraft wire harness.[143]

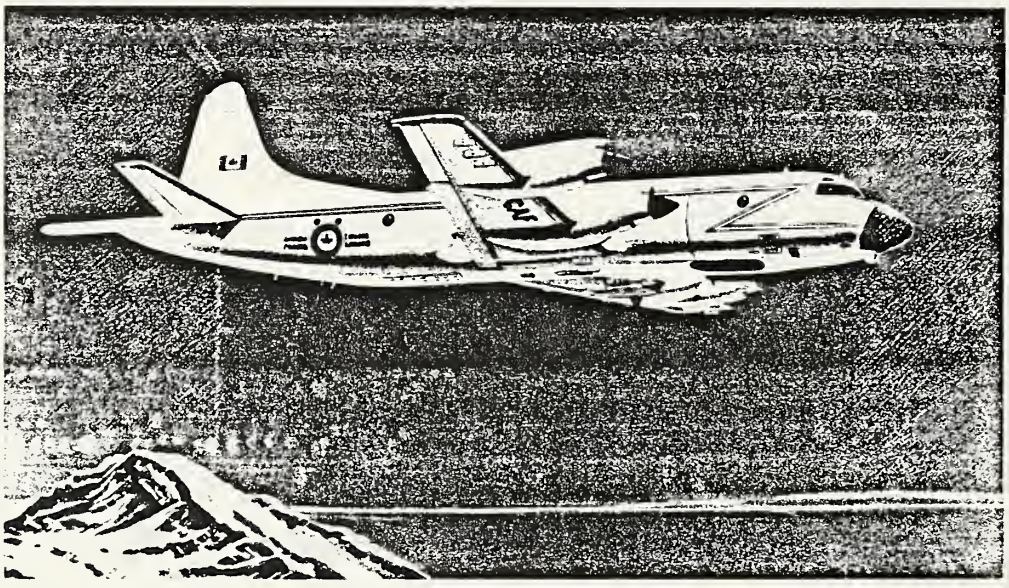
4. Transfer of Manufacturing North of the Border

Lockheed described the manufacturing shift to Canada as "the largest major tooling move in modern history." A total of 17,600 tools were transferred to Canadian facilities and 350,000 parts for startup work were also shipped. To support the move, Lockheed accelerated production of some parts and stockpiled others in anticipation of 3-6-month lapses in production of some items. It fabricated 13,000 small parts to be bagged and transported northward to facilitate a smooth production start at the new fabricating facilities. These steps account for a $12-million boost in Lockheed inventories.[144]

The U.S. Navy acquiesced to the manufacture of P-3C parts in Canada provided it does not have to pay more for parts made in Canada and so long as there is no adverse impact on contractual schedules. Lockheed acknowledged it might have to swallow some expenses corresponding to the difference in costs of parts



Interior of the CP-140 has been modified substantially from the layout used in other derivatives of Lockheed's P-3 family. The tactical crew compartment, located in the center cabin area, is grouped around the tactical navigator's station to improve crew coordination during mission activities. An upgraded galley is situated in the aft cabin, and a flushing toilet is located in the forward cabin.



made domestically and in Canada. The company says it absorbed $9.4 million in added costs in 1977-78 with the transfer of manufacturing.[145] In the event of mobilization in this country, Lockheed could bring the tooling back to the U.S. if Canada for any reason could not meet the demands of U.S. Navy production orders.[146]

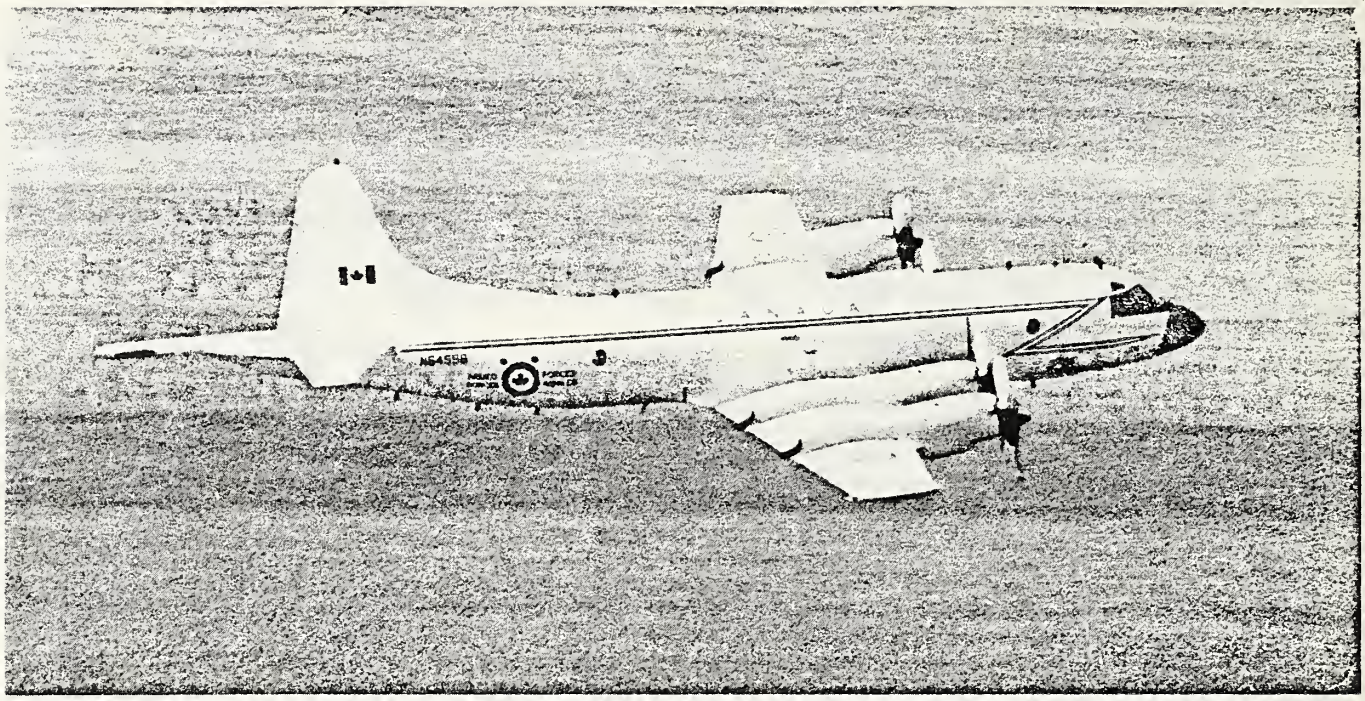
In the January 22, 1979, issue of Aviation Week & Space Technology, Ronald R. Nash, deputy director of the procurement branch for the Canadian Department of Supply and Services stated that: "There were the minor initial problems that can be expected when tooling and parts are shipped to set up new assembly facilities, but there have not been any delays in aircraft deliveries caused by the Canadian participation in the P-3 production."[147]

5. The CP-140 Aurora's Mission Avionics

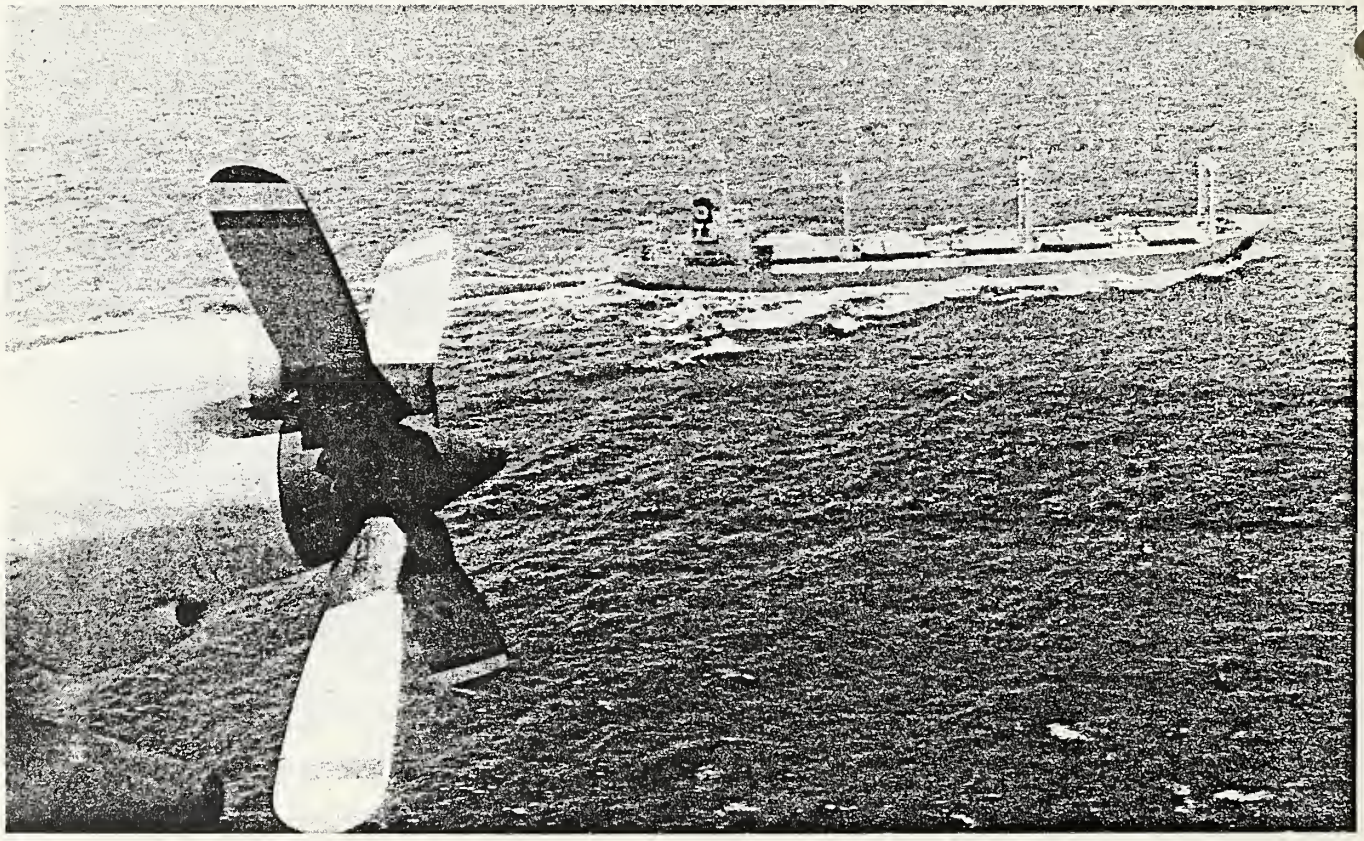
The Aurora payload is substantially different from the avionics normally carried on the P-3C because of the peculiar Canadian mission requirements. New ground support equipment is also required.

A significant portion of the aircraft's avionics comes from a later aircraft, the Lockheed S-3A:

- Univac AYK-10 central processor;
- Texas Instruments APS-116 forward looking radar (FLIR) and forward infrared sensor;
- IBM ALR-47 receiving system utilizing wing-tip antennas;
- Cubic Corp. sonobuoy reference system, and;



Lockheed/Canadian Forces CP-140 passes near a tanker ship target during a simulated maritime mission off the California/Mexican coastline. Outboard engines are shut down to conserve fuel during flight at the lower altitudes.



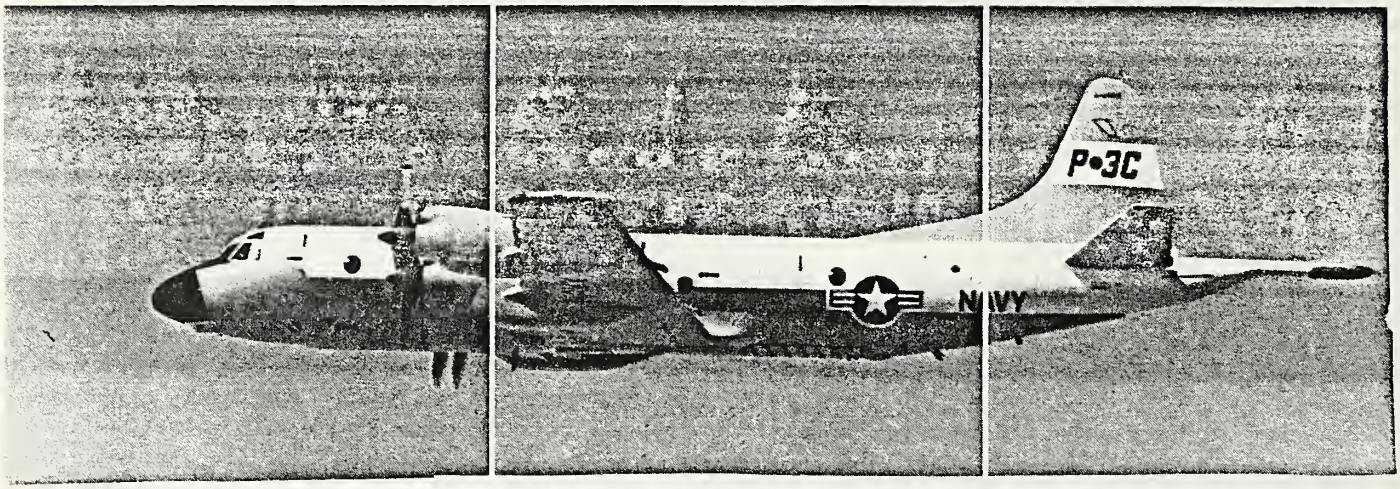
- Sander Associates OL-82 acoustic data processor.

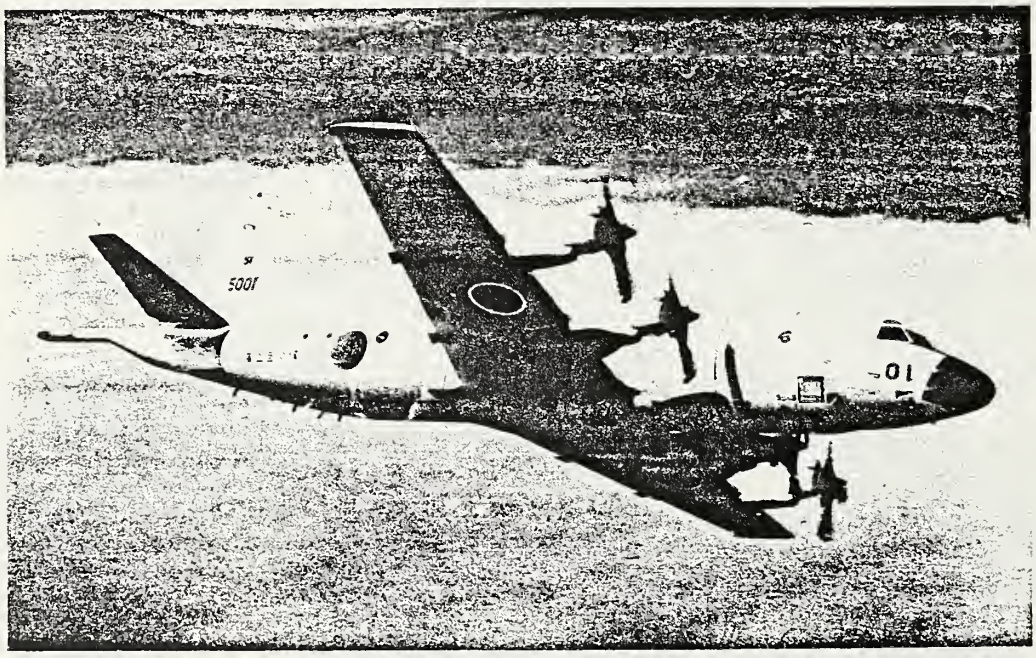
The CP-140 will have a significant percentage of Canadian-built avionics, mostly accomplished by Canadian companies directly under subcontract to Lockheed. This largely represents new equipment. Canadian avionics equipment includes a magnetic anomaly detector and auto compensation equipment, made by CAE Industries, Ltd., Montreal, a day or night reconnaissance camera made by Canadian Zeiss, a Canadian Marconi Doppler navigator plus various communications, identification and other navigation aids. [148]

Other CP-140 equipment was procured directly by the Canadian Department of Supply and Services from Canadian suppliers. Chief among these was CAE of Montreal which supplied the Canadian Armed Forces with the flight and operational mission simulator for the CP-140. This in turn was to lead to additional sales of CAE simulators to another recent foreign customer of the P-3C, the Netherlands (who also procured their P-3C's under a Mode #6 offset arrangement, see Chapter 5).[149]

6. Lockheed's Perspective

Despite the burden of heavy offsets, Lockheed views the CP-140 program as an important one in that it has resulted in improvements that make this version of the P-3 a better aircraft, enhancing Lockheed's competitive position in the domestic and overseas land-based anti-submarine warfare aircraft markets. Furthermore, during the interval from 1976 to 1984, it will keep engineers and other skilled personnel in place and contribute to maintaining the P-3 line.


P•3C
NAVY


5001
10

The program will be responsible for 7.7 million man-hours of P-3 production work here at Burbank and 3 million in Canada. Without the CP-140, the man-hour figure during these years here would total 12.6 million on the P-3 program. Hence, the program is responsible for a 60% increase in local P-3 work.[150]

Lockheed believed the high percentage offset arrangement of the type developed for the CP-140 will be a pattern-setter for any future Canadian programs, such as the later fighter procurement, but not for other international programs where the offset percentages are usually considerably lower (30% being a very common figure).

G. The Canadian New Fighter Aircraft (NFA) Competition

1. The Military Requirement

In mid-1977 contenders from the U.S. and Western Europe lined up for the Canadian New Fighter Aircraft (NFA) competition. The winner(s) would receive a $2.34 billion (Canadian dollars, August 1977) order for between 130 and 150 aircraft (a total that was to include spares, support, construction and training costs).

The NFA would replace a total of 260 aircraft in the Canadian Forces: McDonnell CF-101 Voodoos, Lockheed CF-104 Starfighters, and Northrop CF-5s.

These three aircraft fulfilled two Canadian requirements collectively: that of North American air defense involving a long-range interceptor in line with its U.S. - Canada commitment; and that of tactical fighter for Central Europe under its agreeement with the North Atlantic Treaty Organization. Over the following three years of the competition, as selection deadlines repeatedly slipped, a major issue was to be whether one economical aircraft could adequately fulfill both of these requirements. Given the budgetary limitations, however, the Canadian government was known to favor a single multi-purpose aircraft as the most cost effective choice from the beginning. Ottawa, however was not to make a firm decision on this point up until its November 1978 announcement of the "short list".

The original contestants in the race included the Grumman F-14, the McDonnell Douglas F-15, the General Dynamics F-16, the McDonnell Douglas F/A-18A, the Northrop F-18L, the Panavia MRCA Tornado, and two Dassault-Breguet entries the Mirage 2000, and the Mirage F-1. The French dropped out almost immediately, however.

2. Offset Requirements

In addition to price and the more purely military considerations, the Ottawa government emphasized the importance of the commitment as to the amount and type of the production work that would be returned to Canada before it committed its dollars. The recently awarded (1976) Lockheed contract for 18 CP-140 Aurora maritime partrol aircraft (a derivative of the P-3C Orion) was commonly felt as having set a precedent, one in which close to 100% of the cost would be offset with work in Canada.[151]

For the NFA competition,

> Ottawa imposed a requirement that contenders for the order specify what offsetting investments they propose to make in Canada. Canada asked each of the competitors specify the products or activities that would be carried out by Canadian industry, the value of goods purchased, the level of employment created and the technology enhanced or developed in Canada. As if this weren't demanding enough, the competitors had to contend with the decline of the Canadian dollar and a hefty 12% sales tax.[152]

In mid-1978, Canada's Minister of National Defense, Barney Danson, outlined at the semi-annual meeting of the Air Industries Association of Canada in Ottawa

a seven-point industrial strategy aimed at attracting the highest benefits for the country's aerospace industry from the New Fighter Aircraft program.

The seven key elements to the government's approach were to be:

- a combination of contract quantity and quality;
- a reinforcement of special skills already attained by the Canadian aerospace industry;
- development of new skills, technologies and products;
- broadening of offset benefits beyond the defense production sector;
- preference for long-term proposals over short spurts of production;
- a regional distribution of offset benefits, and;
- a balance between defense spending and development of Canadian industry generally.[153]

3. Selection of the Two Finalists

In November 1978, the Canadian government announced its decision narrowing the six remaining contenders to two, the General Dynamics F-16 and the McDonnell Douglas F/A-18A. The final decision was expected at this time to be sometime the following spring, the government of Pierre Trudeau wanting the decision out of the way before the national elections scheduled for July.

Following are exerpts of Canadian Defense Minister Barney Danson's statement in the House of Commons on the selection of the F-16 and F-18A as the finalists in Canada's fighter competition. He details why they made the "short list"

and compares their relative advantages in meeting the country's domestic and NATO defense commitments.

> Direction has now been given to the interdepartmental program office to initiate discussions leading to the negotiations of draft contracts with the two prime manufacturers remaining in competition. In addition to the very important question of aircraft capability, fleet size, delivery schedule and optimum phasing of payments, emphasis will be placed on negotiating the best mix of industrial benefits for Canada. In these negotiations particular attention will be paid to arrangements that could contribute to the growth of research and development activity in Canada as well as high technology industry which complements our geography and our resources. Emphasis also will be given to ensuring that all regions of the country will have full opportunity to participate in this program.
>
> Our numerical requirement of between 130 and 150 aircraft is critical to our capability to meet our domestic and European commitments. We are indeed disappointed that procurement of sufficient numbers of F-14s, F-15s or Tornados could not be accommodated within our set budget of $2.34 billion (August 1977 dollars).
>
> Our evaluation also revealed that acquisition of a mixed fleet would bring little or no benefit in terms of fleet size and that operation of such a fleet would bring substantial liabilities including double training and logistic support systems over the life span of the aircraft.[154]
>
> The two most severe constraints that we face and will continue to face are the number of aircraft required and the set amount of money to buy them. Our task, then, is to buy the best military aircraft available within those constraints, while seeking the best possible industrial benefits with a minimum of project risk.
>
> In addition to cost and numbers, there are other considerations that serve to favour the two aircraft we have kept in the process.
>
> To begin with, there is the military and political assessment that we have made of the current—and to a certain extent, anticipated—strategic situation that we are facing.
>
> A package combining F-14s and F-16s would have helped Canada meet its requirements for air defense of a large continent and its responsibilities to NATO to provide air to ground capability.
>
> We have come to the conclusion that an adequate number of the smaller aircraft equipped with radar guided air-to-air missiles and suitably

deployed across Canada, could afford us the capability to fully exercise our sovereignty by intercepting, identifying, and if necessary, destroying aircraft that might be probing into Canadian airspace. Having this type of prudent capability, we believe, would deter probes and offer adequate protection against the possibility of a bomber attack on the North American continent.

Having eliminated the three most expensive systems from the competition, three remained—the CF-16, the CF-18A and the CF-18L—that met or came very close to meeting our numerical requirements within the budgetary envelope while being able to meet the most likely military challenges.

The CF-18L proposed by Northrop could meet these most likely challenges and probably be acquired in sufficient numbers. Potentially, it also provides a very attractive package of industrial benefits. However, we have assessed as very considerable the risk of committing Canada to buying a sophisticated aircraft that is not in service with any other country. At this time, I consider all the various types of risks which could be involved in the development and initial introduction into operational service of this aircraft are greater than we either need or should be prepared to accept. Moreover, even in the best of circumstances, the delivery schedule of the CF-18L is likely to be markedly behind that required for the timely replacement of our CF-101 and CF-104 aircraft.[155]

The F-16 is a single-engine aircraft which has been selected by five of our NATO allies including the United States. Should the CF-16 be acquired, Canada would of course have extensive commonality with NATO allies in Europe. While this aircraft does not have the degree of sophistication of the larger aircraft, it does have acceptable capability and is the only aircraft which at this point meets the numbers required.

The other fighter remaining in the competition, the CF-18A, offers us another set of possibilities. It may be more expensive than the CF-16 would be, therefore we can expect to acquire fewer although I am optimistic that an adequate number to meet our roles can be acquired in negotiations. Purchase of this aircraft could allow for co-operative logistics arrangements with the United States.

On the other hand, being a twin-engined, somewhat large aircraft, the CF-18A offers some definite advantages of its own. These include a good potential for growth, or a capability to be fitted with new systems that may be necessary to cater to future demands made of a fighter aircraft. The CF-18A also currently has more advanced all-weather capabilities in the context of sovereignty protection and air defense.

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Light weight, high strength, and stiffness are at work in the F-18's wing skins, speed brakes, horizontal and vertical stabilizer skins, and such secondary structures as access doors and fairings.

Our graphite fiber has many other missions in aerospace. It's aboard the Trident, Pershing II and MX missiles. (We also developed the composites for the rocket motor cases of Minuteman, Polaris, and Poseidon.)

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HERCULES



> We expect that a reduction to two contenders will have a very favorable impact on Canadian industry's ability to participate with prime manufacturers in the development of detailed industrial proposals.[156]

At the time of the announcement of the two finalists in November 1978 the McDonnell Douglas F/A-18A Hornet offer for the fixed-price $2.34 billion order stood at 127 aircraft, and the General Dynamics F-16 offer stood at 142 aircraft,[157] i.e., a CF-18's unit cost would be some 12% more than that of a CF-16, with quantities ordered adjusted accordingly.

Minor modifications to both aircraft would be required in order to meet Canadian needs, including all-weather radar and Raytheon/General Dynamics AIM-7F Sparrow missiles on the F-16, night identification lights, electronic countermeasures and related avionics.

4. The Two Finalists' Offset Offers as of November 1978

Each contractor's offer faced a differing, but major shortcoming at this stage. For General Dynamics it was the Canadian government's assessment that it needed to significantly improve the quality of its offsets. For McDonnell Douglas it was the more difficult task of increasing its offer of 127 F/A-18As by an additional 13-23 aircraft.

As of November 1978 "short list" selection the two finalists each offered a package with a value of approximately $2 billion in industrial offsets.

Principal elements in the McDonnell Douglas/Northrop Hornet offset package included:

- Provision of 22,800 jobs in Canada by 1991-92; 8,400 jobs by 1983-84. Canada would participate in parts manufacture, testing, tooling, subassemblies, final assembly, maintenance, test equipment and support of other military aircraft manufactured by McDonnell Douglas.
- Participation in solar energy farm technology.
- Participation in microwave, vacuum grain drying technology.
- Medical supply computer and software manufacture.
- Guidance systems for the air-launched cruise missile (ALCM) and the General Dynamics Tomahawk cruise missile. (Canadian officials were especially interested in this offset, however creditability to MACDAC was an open issue).
- Payload assistance modules for the space shuttle.
- Construction of liquid natural gas transport ships. (One Canadian official doubted the country's shipyards were large enough to undertake such construction.)
- Ion vapor deposition technology (aluminum plating).

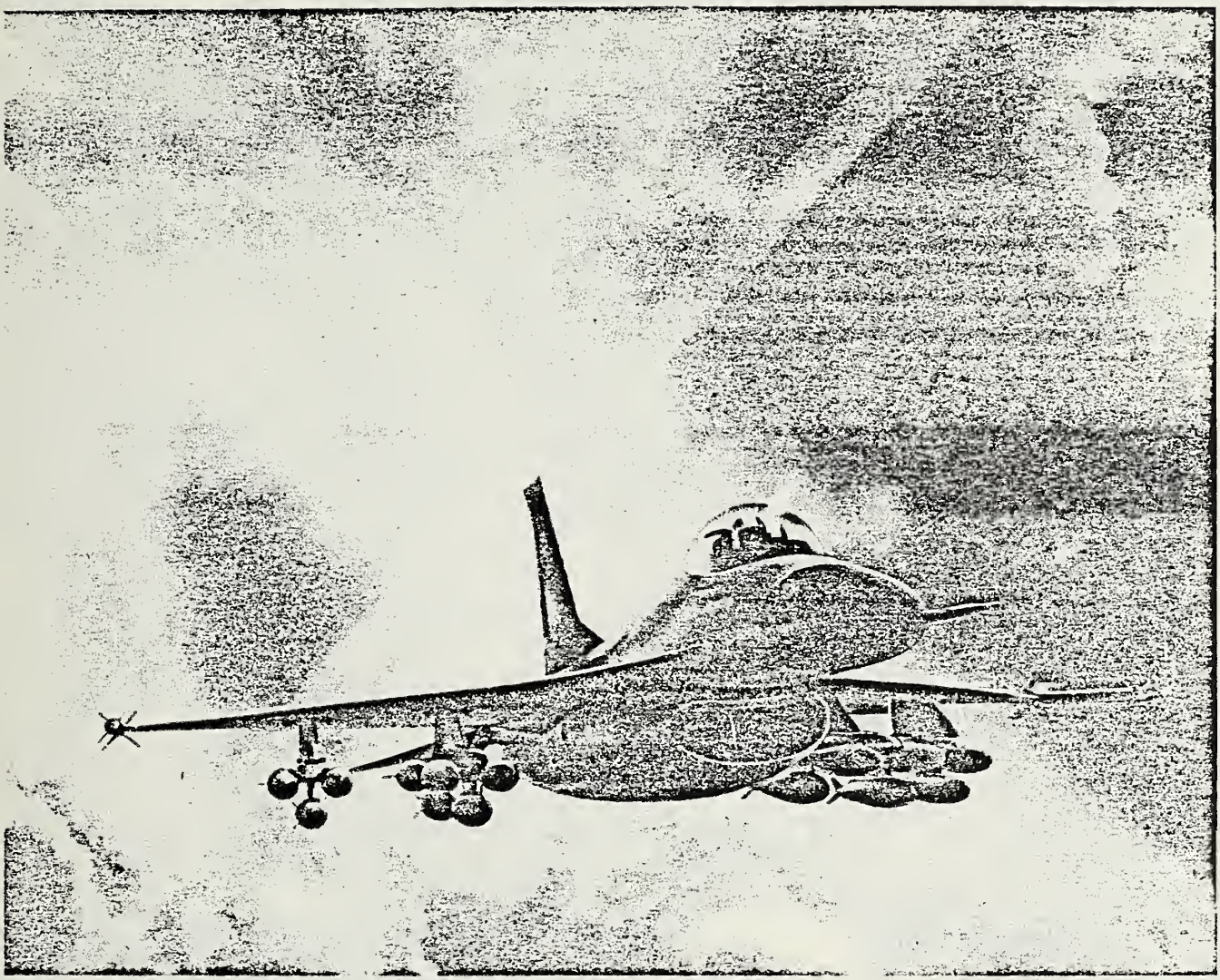
McDonnell Douglas had let $212 million in business in Canada as of Sept. 1 and had aided Canadian firms in making contacts with U.S. industry.[158]

The General Dynamics offsets package included:

- Provision of 19,000 jobs in Canada by 1991. Manufacture in Canada of avionics, subsystems and engine components, plus final assembly of the Canadian F-16's.

- Production in Canada of flight simulators, spare parts, support equipment and technical publications for the Canadian F-16's and manufacture of F-16 components for additional nations.
- Opportunities for Canadian industry to share in commercial and defense programs of General Dynamics and subcontractors.
- Transfer of technology involving digital avionics and advanced composite materials used in surface areas of the F-16.
- Participation in shipbuilding, such as liquid natural gas transport ships, and new military aircraft.
- Significant investment in Canada by General Dynamics, Pratt & Whitney and Westinghouse to create new jobs and exports.
- New venture activity, including a high-technology vacuum casting facility.
- Assistance to Canadian companies in the international marketing of their products.[159]

Earlier in 1978 there had been Industry speculation that the offset requirement would pose a problem for General Dynamics because of its obligation to let Belgium, Denmark, the Netherlands and Norway participate in third country sales. The MOU with the four NATO nations calls for them to participate in 15% of third country sales. General Dynamics however did not see the agreement with the four NATO Nations as posing a particular problem. General Dynamics attitude was one of, even with the 15% requirement, there would still be a lot of participation left to offer Canada.[160]

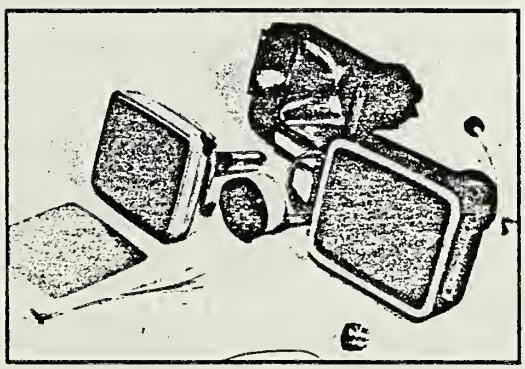


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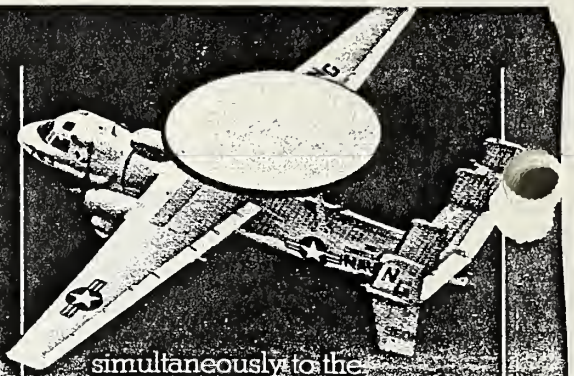
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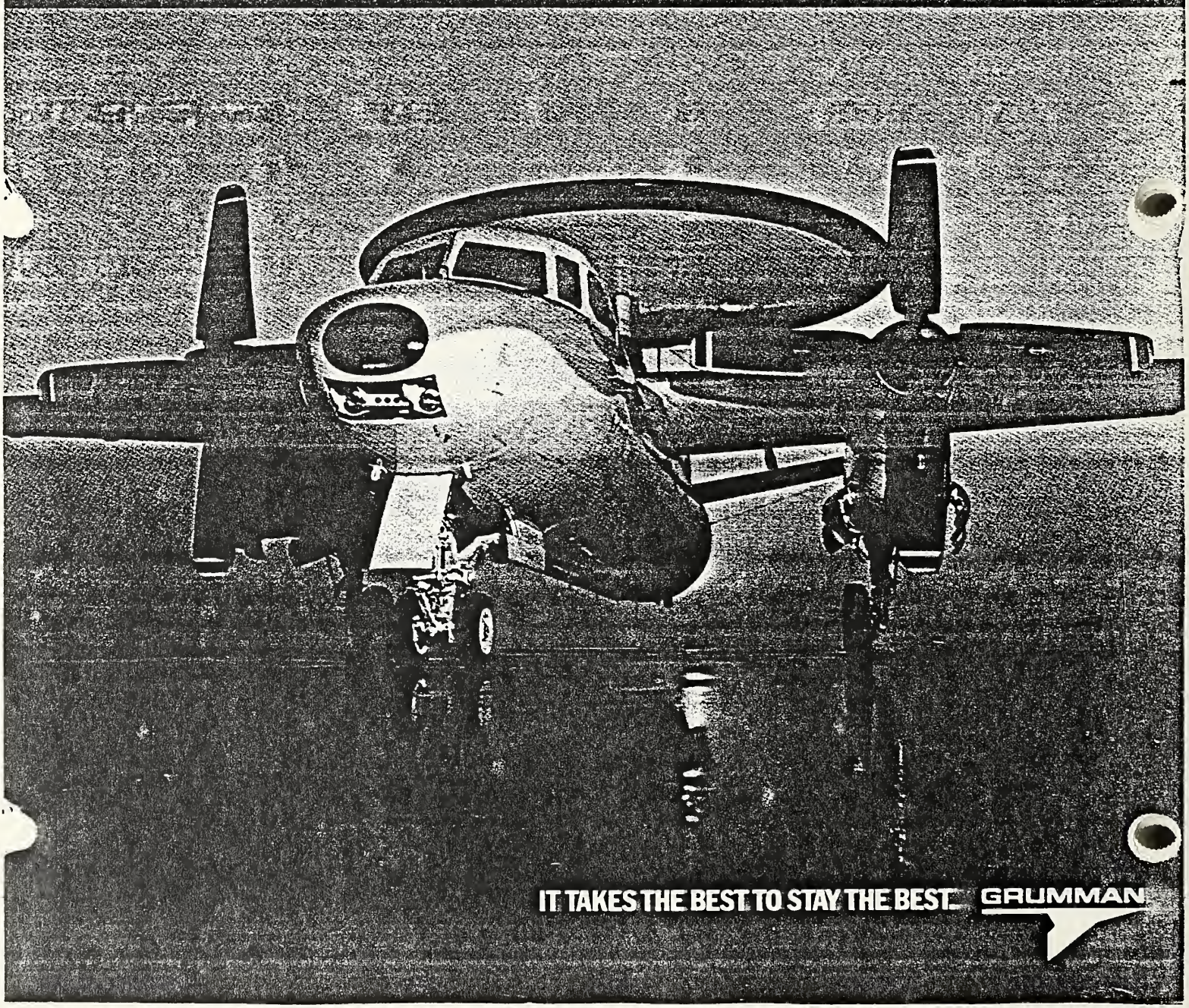
Imagine the congested air corridor between the great cities of the world. Hundreds of aircraft. Scores of ships. An army of vehicles. And such false target reflections as stationary land return, noise and clutter. Add electronic countermeasures and you have a routine surveillance environment for the E-2C Hawkeye.

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IT TAKES THE BEST TO STAY THE BEST. GRUMMAN

Competitive pressure for the NFA was acute, this being reflected in the content of the two industrial teams offset offers. The significance of this competition for the two finalists centered around two issues. For McDonnell Douglas it would be the first export order for the F/A-18A, while for both contractors, it was felt the sale would have a major impact on pending and future foreign competitions.

Although McDonnell Douglas had orders for 1,377 F-18As from the U.S. Navy, it had yet to receive a foreign contract for the plane. A Canadian order would give it international standing. The General Dynamics F-16 on the other hand had a total order base as of mid-1979 of 1,811 including 1,388 from the USAF, 348 from the collective Belgian-Dutch-Norwegian-Denmark order and 75 from Israel.

If Canada picked the F-16, the General Dynamics plane would have a commanding position as the North Atlantic Treaty Organization's fighter. But if Canada opted for the F-18A or another fighter, other countries might be inclined to do likewise. The F-16 and F-18A were also among contenders for an Austrailian contract for an initial 75 fighters and a Spanish order for 144.

5. Selection is Postponed and Competitive Pressures Increase

As things turned out, the selection of the NFA was to be postponed for what was to be another year from the scheduled date. Though the government of Prime Minister Pierre Trudeau was planning to get the selection out of the way before calling an election in the summer of 1979, his government collapsed and the election occurred sooner than he had planned, one which his Liberals lost.

With the new conservative government of Joe Clark taking office on June 4, 1979, the competition took a new twist. Though the new government continued contract negotiations with General Dynamics and McDonnell Douglas, it stated that it wouldn't consider itself bound by the Trudeau government's two-plane list.

The new Conservative government proceded to ask the U.S. whether Canada could get cut-price terms on 78 USN/Grumman F-14 fighters that had been sold to Iran but which Iran wanted to sell back to the U.S. The F-14, as well as the F-15, was highly rated by Canadian pilots but dropped from contention the previous November because it was too costly.[161] The U.S. agreed to discuss the matter with Iran but nothing ever came of it, and the competition continued as previously with only the two-plane short list.

The new government pledged to make its choice by the end of the year. Joe Clark's Progressive-Conservative government in turn collapsed, however, 1-day before the decision was to be announced, and elections were called again, which led to the Liberals being reinstated, after 9-months out of power, in February 1980.

Meanwhile with competitive pressure building, both the McDonnell Douglas and General Dynamics offset offers had been increased, as well as being worked out in greater detail.

6. McDonnell Douglas' and General Dynamics' Offset Offers as of the Fall of 1979

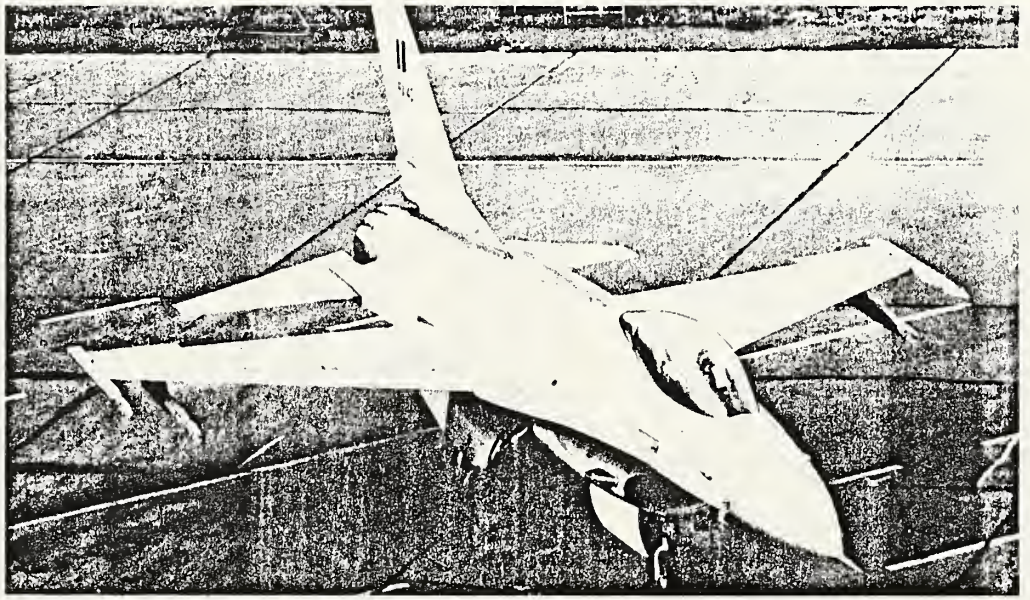
Canada's Defense Minister, Allan McKinnon, said that as of the fall of 1979, with the Conservative government's decision only weeks away, both the GD and McDonnell Douglas/Northrop offset proposals were "fairly close together."[162]

As of November, 1979, McDonnell Douglas had increased its offer to $2.6 billion. This total consisted of $700 million in internal offset work related to F/A-18A and CF-18 work, plus another $1.9 billion in external offset work ranging from aerospace-related programs to non-industry benefits, including tourism promotion. This total of $2.6 billion in work would result in 24,000 over the 1980's of which 8,000 would be aerospace related.

McDonnell Douglas proposed that it would provide the Canadians with 150 CF-18s, with deliveries starting in 1982, based on a go-ahead in 1979.

At the option of the Canadian government, the proposal offered final assembly and test in Canada of the Canadian Hornets plus another 100 F/A-18s sold to third countries, excepting those countries that would contract for coproduction programs.[163]

Canadian CF-18 content would include the forward fuselage nose barrel, center fuselage barrel, engine inlet nacelles and boundary layer control ducts and forward fuselage side panels, while McDonnell Douglas' F/A-18 suppliers would



Des F 16 de General Dynamics pour la FAè B (Adj. E. Moreau).

provide packages related to the aircraft's engines, avionics and other equipment and support.[164]

McDonnell Douglas had earlier proposed farming out approximately $500 million in DC-9 and DC-10 work already being performed in its Canadian plant, but the government ruled against counting that because the work had been started prior to March 18, 1977, the deadline established in the new fighter aircraft program for creditability of new work.[165]

In the advanced technology area, McDonnell Douglas had been working with numerous Canadian companies, leading them to acquire improved manufacturing capability that would be applicable to future programs. This included the manufacture of graphite epoxy components which would involve the use of such advanced manufacturing technology as laser cutting tools, along with an offer to assist prospects in Montreal and Ontario in setting up a manufacturing facility containing a machining center having five-axis direct numerical control.[166]

This included the making available to Canadian firms of 27 licenses and technical assistance covering proprietary processes. These include a McDonnell Douglas-developed advanced plating process, a system for high-volume economical fabrication of sheet metal small pars, a cryogenic wind tunnel that makes possible attainment of high Reynolds numbers with small models, cryogenic heat pipe for anchoring pipelines above ground surfaces without disturbing critical environmental temperatures, a cryogenic, heat-resistant muffler material

developed as a fallout from space program work, technique for providing flush-crown rivets in metal assemblies without shaving, a microwave vacuum system that is applicable to drying agricultural products, technology related to fastener manufacture and a guaranteed workload to support DC-9 and DC-10 production, and technology support in developing wind energy generating devices. The company also offered to work with Canadian companies as a partner in developing solar electric equipment and cryogenic insulation that would be applicable to a liquid natural gas transport that is in the design stage in Canada.[167]

The McDonnell Douglas proposal also offered to establish an office with its principal F-18 partner, Northrop, in Canada to promote exports of all types of Canadian products, utilizing the worldwide marketing contacts of the two firms.

The value of the aerospace-related portions of General Electric's proposed offset would be about $250 million, about half the total corporate G.E. offset effort. Its total proposal included increased purchases in Canada by many divisions, including industrial and consumer products operations.[168]

As of November, 1979, G.E. had awarded an initial $2.5-million contract to Bristol Aerospace, Ltd., for the Hornet's F404 engine exhaust frame assemblies, and a contract for more than $1 million to Walbar Machine Products of Canada for F404 low-pressure nozzle assemblies, which have a potential value of $50 million. G.E. was still considering several other F404 components bids, as well. These initial F404 contracts were firm regardless of whether the CF-18

was chosen, though if the airplane was not selected by the Canadians, G.E. would naturally reassess placement of follow-on contracts to these companies.[169]

In addition, General Electric was considering the establishment of a $70-million commercial and military turbine engine blade and vane manufacturing facility in Canada that would employ 400 persons and develop more than $400 million in sales over a 15-year period. General Electric had been studying the development of additional capacity in the U.S. With the advent of the Canadian fighter program, it extended its site search to north of the border.[170]

Here we see Northrop's offset formula previously used on the Swiss F-5E sale in 1975, marketing to third countries was also applied as part of the CF-18 sale. Northrop was able to claim several years later that they were able to quickly exceed their goal of helping Canada find markets for $30 million worth of products.

As part of this sale, Northrop helped line up a customer in Liberia for a Canadian maker of paper cups.

Company officials say the sale of the paper cups came as the result of a chance meeting in Liberia between an alert Nigeria-based Northrop representative and a businessman who expressed an interest in importing paper products.[172]

The new plant would be a General Electric Aircraft Engine Group and Canadian General Electric joint venture, conditional upon the CF-18 being selected. This new facility would be operational in 1983-1984.[173]

General Electric Aircraft Engine Group believed the Canadians were very interested in having the new fighter aircraft engine final assembly and test programs in their country and would lean toward financing the nonrecurring setup costs, including tooling and training. In November the company was in the process of sending detailed requests for proposals concerning this work to CP Air, Orenda Div. of Hawker Siddeley, Rolls-Royce (Canada) and Standard Aero. It estimated the value of this work at approximately $10 million.[174]

Other McDonnell Douglas suppliers that would provide Canadian offset work included Cleveland Pneumatic (landing gear), National Water Lift (actuators), Hughes Aircraft (radar data processor), Conrac Corp. (stores management, set assembly and test and component production), Garrett AiResearch (environmental control system and auxiliary power unit), Litton Systems, Ltd. (inertial navigation system and advanced test equipment).[175]

There was also a plan to have IMP, Dartmouth, Nova Scotia, handle coproduction of wire harness assemblies for the entire F/A-18 program, including the CF-18.[176]

General Dynamics had been able to announce by October, 1979, that it had chosen most of the Canadian companies it would team with if Canada chose the F-16 as its NFA. The decision was still expected by year-end. The GD proposal

included a total of $2.4 billion (Canadian) in offset work and was expected to generate more than 20,000 Canadian jobs during the 1980's. $1.1 billion of the total CF-16 industrial investment would go to the high technology aerospace and electronics sectors of the Canadian economy. Its program included final assembly and test in Canada of approximately 200 CF-16s, including 50 airplanes for sale to third countries. As of October more than $75 million (Canadian) in purchase orders had already been placed with Canadian firms.[177]

The program—described by GD as "the product of the same team of corporations which established the multi-billion dollar F-16 multi-national coproduction program" with four NATO nations—had four major elements:

- Direct work in Canada. In addition to final assembly and test of the aircraft and its Pratt & Whitney engines, this work also included assembly and test of an additional 50 F-16s for sale to other countries. Also, Canadian industry would supply U.S. companies with CF-16 avionics and subsystems and other products, as well as support equipment and spares for Canadian-manufactured systems and components.
- Marketing assistance. GD said it will "establish a team of international marketing specialists to expand international marketing of Canadian products and services."
- Investments. This included "direct investment in Canada in industrial and/or technical projects, joint ventures or businesses; establishment of a new vacuum casting facility in Canada for the manufacture of turbine

engine components," and "transfer to Canada of a high technology electronic product line."

- Purchases. In this category, said GD, are: "procurement of goods and services from Canadian sources of supply by General Dynamics Corp. and its suppliers, including United Technologies Corp., prime contractor for the CF-16's F100 engine; industrial benefits generated by European firms and governments involved in F-16 coproduction; involvement of Canadian industry in General Dynamics' advanced programs, including interchange of advanced technology with Canadian industry," and "employment of Canadian personnel and use of Canadian products in international projects."[178]

General Dynamics characterized its plan as one that "emphasizes the development of high technology aerospace and electronics capability within Canadian industry, establishes resources to multiply sales of Canadian products in the world market, commits substantial capital resources for the establishment of new businesses and manufacturing facilities in Canada, and pledges General Dynamics, many of its divisions and its U.S. and European suppliers to expanded purchases of Canadian goods and services."[179]

With the fall of Prime Minister Joe Clark's minority government on December 13, 1979, Clark said that although his cabinet had been prepared to make the fighter choice, he believed it no longer had the authority. Consequently the decision on Canada's new fighter aircraft would be deferred until after nationwide elections were held February 15, 1980.

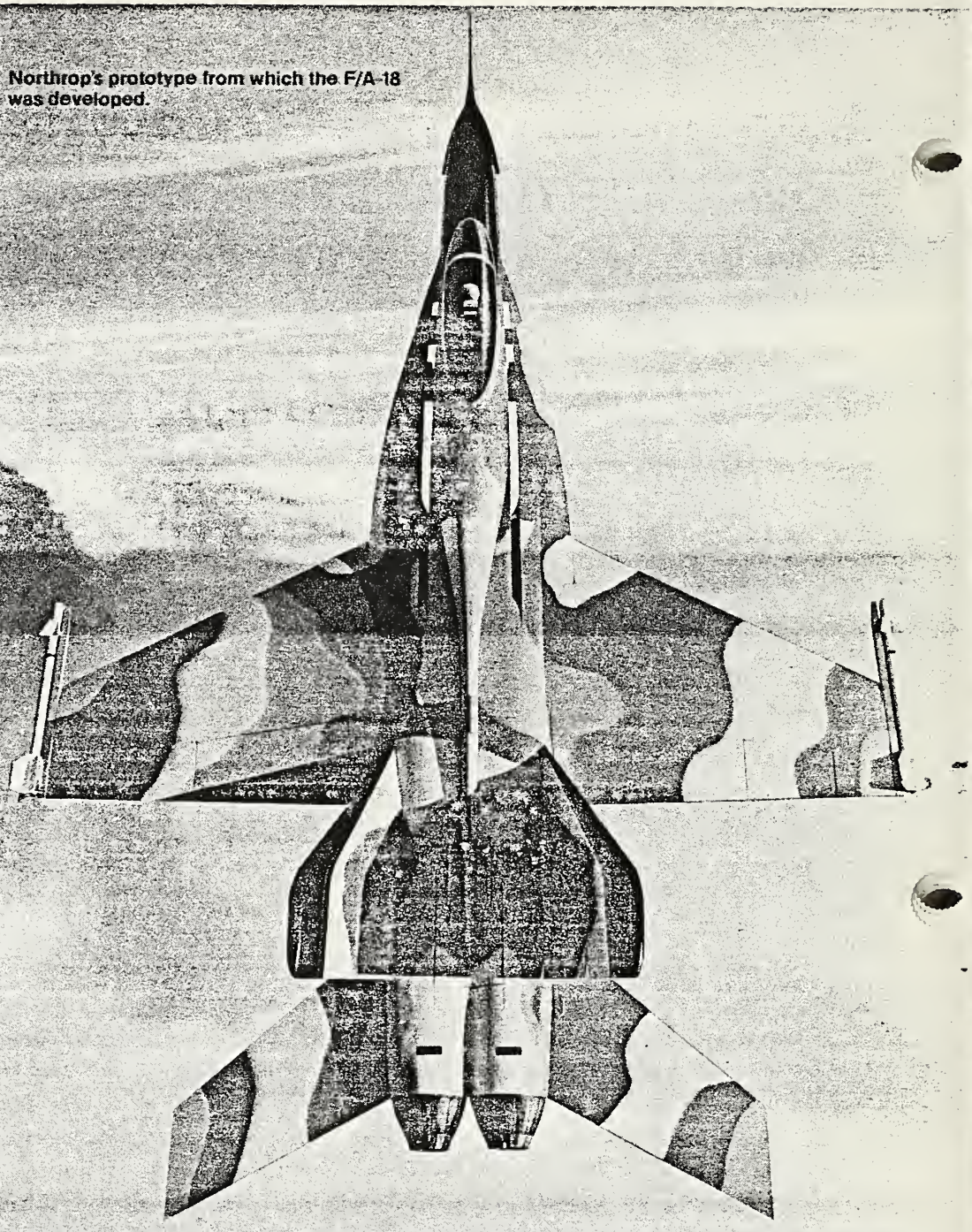
In the interim, McDonnell Douglas (MDC) proceeded to find itself embroiled in two offset related disputes, one with its industrial partner Northrop and the other with the Department of Defense.

7. The McDonnell Douglas - Northrop Suit Over Their Teaming Agreement and Canadian Work Distribution

Under a 1974 joint venture agreement Northrop licensed MDC to utilize Northrop YF-17 technology for a carrier-suitable derivative, the F/A-18A, for sale to the U.S. Navy and foreign countries. The YF-17 was Northrop's entry in the USAF Lightweight fighter prototype competition against th YF-16 of General Dynamics. GD's YF-16 was selected in January 1975. For its derivative of the YF-17, MDC would act as prime contractor and follow a 60:40 split of prime contractor work between itself and Northrop (as a rule of thumb, an aircraft prime contractor obtains 55% to 60% of program funding). Northrop would act as prime contractor with the work sharing ratio reversed for the land based version, the F-18L. The version of the F-18 being offered to Canada was essentially similar to that of the USN's F-18.

On October 26, 1979 Northrop filed suit in a Federal Court in Los Angeles asking for a preliminary injunction to prevent MDC from "further violations" of agreements between the two companies, and to stop McDonnell Douglas from "unilaterally offering to foreign countries" the opportunity to manufacture Northrop portions of the F/A-18 strike fighter. Northrop charged that Douglas had proposed that Canadian concerns perform "substantial portions of the work" that Northrop was

RELIABILITY



Northrop's prototype from which the F/A-18 was developed.

When the U.S. Navy and Marine Corps needed a single versatile aircraft to replace both the F-4 Phantom and the A-7 Corsair, they selected the multi-role F/A-18 Hornet.

The F/A-18 provides dogfight capability superior to any tactical fighter in the Navy inventory.

Light attack capability greater than any airplane in the Naval attack community.

And something more: reliability projected to be three times that of either of the two aircraft it will replace.

Northrop is associated with McDonnell Douglas, prime contractor to the U.S. Navy, for development and production of the Hornet. Northrop will be prime contractor for derivatives designed for land-based operations.

The F/A-18 Hornet. More capable. More reliable.

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Making advanced technology work.

entitled to perform under the "teaming agreement" signed in 1974 for development of the F-18.[180]

According to the Northrop complaint, McDonnel Douglas offered the Canadians "specific work in connection with the center and aft fuselage" (part of Northrop's 40% on the planes the Canadians would order), and on half of all the planes that would be built for all other customers, including the aircraft being built for the U.S. Navy and Marine Corps.[181]

A Wall Street Journal article stated that, "The unusual legal action between the two F18A contractors clouds the chances of the F18A in its hotly contested competition with General Dynamics Corp.'s F16 for the Canadian order..."[182]

Five weeks after the injunction had been filed, McDonnell Douglas and Northrop agreed to remove the Canadian F-18 offer from the dispute between the two companies. Agreement was reached without concessions from either company and was intended to dispel any doubts surrounding the fulfillment of offset agreements associated with a Canadian F-18 order.[183]

McDonnell Douglas, threatened with the injunction by Northrop Corp., agreed in federal court to not subcontract work pledged to Northrop to Canadian companies as part of the proposed sale to Canada pending the courts resolution of its rights. Moreover, McDonnell agreed to modify the design of the F-18A being offered to Canada so that the aircraft will be capable of aircraft carrier operations. This was necessary because Northrop, which originally developed

the F-18 design for the Air Force, contends that it has prime contracting rights for any F-18 model that is not designed for carrier use.

With the McDonnell concessions, Northrop agreed to withdraw its request for a preliminary injunction blocking McDonnell from seeking the Canadian fighter contract.

At the same time, Northrop was still seeking an injunction to prohibit McDonnell from selling and F-18A incapable of carrier operations to Israel, and possibly other countries, and to prevent the company from subcontracting work to third parties that is pledged to Northrop under the teaming agreement. Northrop itself was seeking to sell its land version of the F-18 (F-18L) to Israel.[184]

After the court denied Northrop's motion, on December 13, Northrop filed an amended complaint, asserting additional claims. The new claims, were that MDC had fraudulently induced Northrop to enter into agreements establishing a confidential relationship under which Northrop furnished YF-17 technology to MDC, and that MDC had attempted to monopolize an F-18 market by actions, claimed to involve unfair trade practices.[185]

In addition to the injunctive relief previously sought, Northrop now sought to recover not less than $100 million compensatory damages (by various means, including an accounting to Northrop for MDC's F-18 profits or as the value of the technology furnished to MDC), $300 million punitive damages, and further injunctive relief."[186]

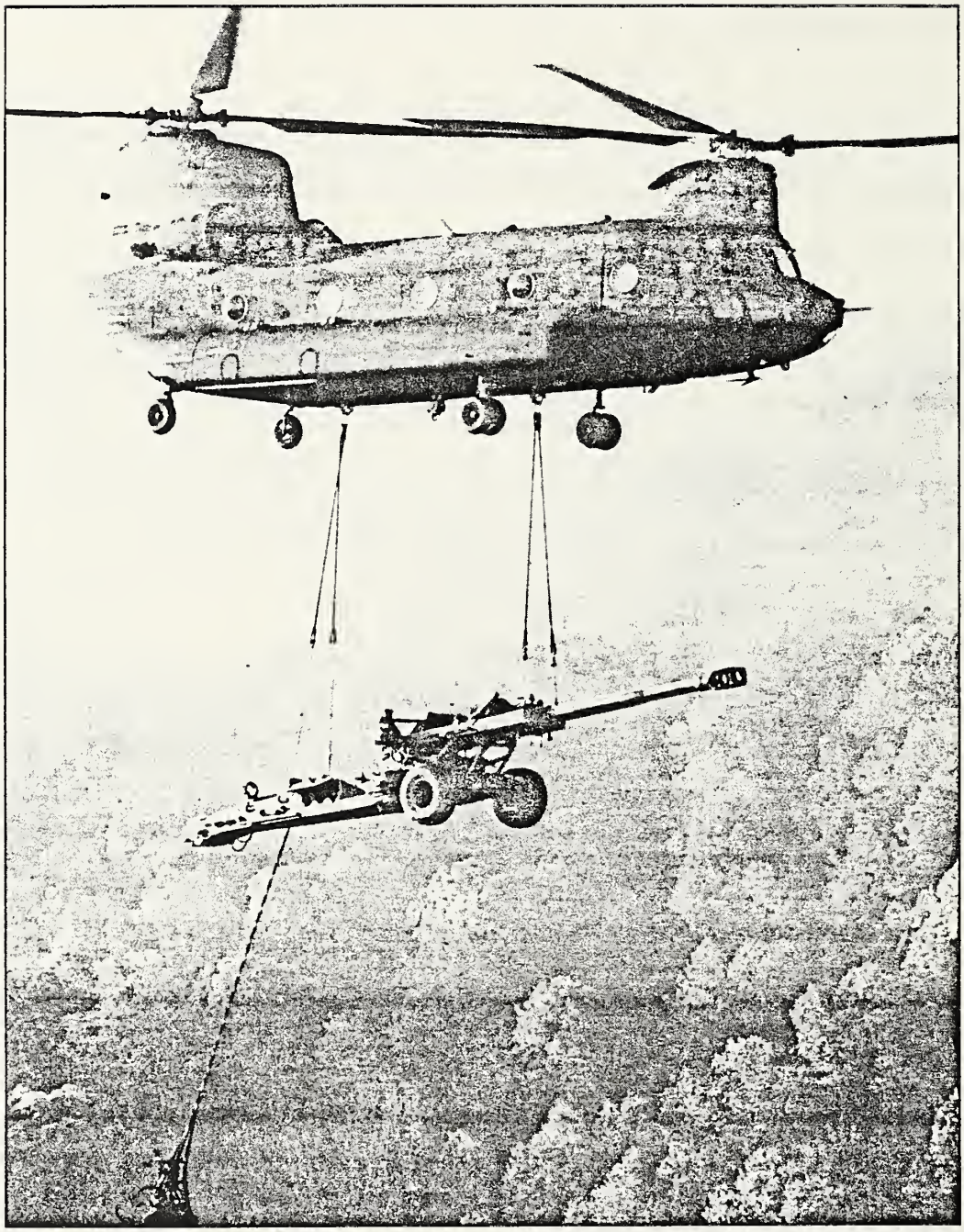
On December 26, McDonnell Douglas filed its denial of the amended complaint, and its counterclaims.

In its Form 8-K SEC filing, McDonnell Douglas said that it is seeking declaratory and injunctive relief, as well as the $100 million-plus monetary relief, for Northrop's "among other things...continuing violations of the teaming and resultant agreements of the parties, the unlawful restraints of trade which will result from Northrop's interpretations of the agreements, Northrop's misrepresentations of its right to sell and perform work on F-18 aircraft under such agreement, and Northrop's fraudulent inducement of MDC to enter these agreements if interpreted as alleged by Northrop."[187]

Denying the other company's allegations, MDC said it is "entitled to sell F-18 aircraft of basically the same configuration as the F-18s sold to the United States and foreign countries, and...Northrop does not have an unqualified right, regardless, for example, of foreign offset business requirements, to perform specific work on such activity.[188]

8. McDonnel Douglas Versus the DoD on the Creditability of its Government Furnished Cruise Missile Work

Meanwhile a second Canadian offset related issue had become a point of contention. This involved the credibility of an inertial guidance system (INS), one that is provided by MDC as GFE to the system prime contractor for the USAF's Air Launched Cruise Missile (ALCM), Boeing. In mid-November the U.S. Defense



A US Army CH-47D transports an MI.98 (155mm) howitzer

Department asked the Canadian government not to credit the $545 million INS contract to the McDonnell Douglas CF-18 proposal.

The DoDs objections were expressed in a letter from Dale W. Church, deputy undersecretary of Defense for acquisition policy, to Barry C. Steers, assistant deputy minister in Canada's Ministry of Industry, Trade and Commerce.

> "It has been brought to my attention under the New Fighter Aircraft (NFA) program industrial benefits that $545 million in Cruise Missile Guidance has been incorrectly included under the heading for a McDonnell Doublas Corporation offset. This particular item as discussed with your Embassy staff in Washington the day before we decided to consent to the award for a contract to Litton Systems, Ltd. of Canada as a seocnd source for inertial guidance systems (INS) for our air-launched cruise missile (ALCM) program. In these discussions it was agreed any offsets relating to such an award would accrue to the U.S. Government and neither of the two respective U.S. competitors for the new fighter aircraft. However, the amount could later be used at the discretion of the U.S. by the winner to cover shortfalls in the offset program. Your staff communicated this to your office, and we were notified of agreement on this matter. Based on this agreement, it is our understanding that the inclusion in the McDonnell Douglas column is in error, and that you will make the necessary corrections to remove the item accordingly.
>
> We appreciate your cooperation in this matter in that a commitment had been made to both companies that the INS award would not affect competition in the aircraft program. I have voiced this concern to James Bond of your office in the Embassy in Washington, and I understand he has communicated it to you. We appreciate your timely action in this regard."[189]

In the November 26, 1979 issue of Aviation Week & Space Technology, it was reported that McDonnell Douglas had adopted the position of "...leaving it up to the Canadian government to make the decision whether the $545-million production offset credit for the Litton cruise missile inertial guidance system can be included in the CF-18 proposal."[190]

9. The Liberals Form a New Government and the 'What's Best for Quebec' Controversy Arises

The Liberals won the February, 1980 election, and Prime Minister Trudeau proceeded to form a new government.

The new Defense Minister, J. Gilles LaMontagne promised to announce a recommendation to Parliament by mid-April, a deadline that was finally kept.

In the interim however, one more public controversy cropped up and had to run its course. Pratt & Whitney had reportedly succeeded in convincing four members of parliament, led by Jacques Olivier, representative from Longueuil, near Montreal, that the General Dynamics F-16 offset package was better than that for the CF-18 offered by McDonnell Douglas, and they decided to take their case to the Canadian press. Olivier was also convinced that it was better for his native Quebec, where a referendum was to take place in June on whether Quebec was to maintain its provincial relationship with Canada. McDonnel Douglas stated that it refused to "stoop to that level."

To further embroil matters LaMontagne's staff told the press that McDonnell Douglas has been vague and skimpy with information on its offset package. McDonnell Douglas was bound by a clause in the proposed contract to provide $3 billion in offset to Canada, with $1.3 billion going to Quebec.

Canadian military officials, still concerned over durability of the General Dynamics F-16's Pratt & Whitney F100 engine, viewed the entire matter as a "passing phase" that has been overplayed by the Canadian press.[191]

It was feared at the time that the political controversy created by Olivier might further delay LaMontagne's imminent announcement of his government's decision. Fortunately though, it did not.

In the final days before the decision was announced, McDonnell Douglas again increased its offset offer to Canada to $3,260 million compared with $2,620 million for General Dynamics. Of this former amount, Quebec was to get 48.2%, Ontario 39.7% and the rest of Canada 12.1%. The final sweetener was introduced by General Electric which decided to locate its $60 million blade and vane manufacturing plant for the F404 engine in Quebec.

10. The McDonnell Douglas/Northrop CF-18 Hornet is Selected

The decision was finally announced on April 15, 1980. The McDonnell Douglas/ Northrup CF-18 Hornet was selected. Under the contract the company was to provide 137 aircraft, but the actual number was still a function of whether, and to what extent, the U.S. government would waive its charge for non-recurring development costs. Depending on if and to what extent this was waived the actual number was expected to fall somewhere between 129 and 147 aircraft.

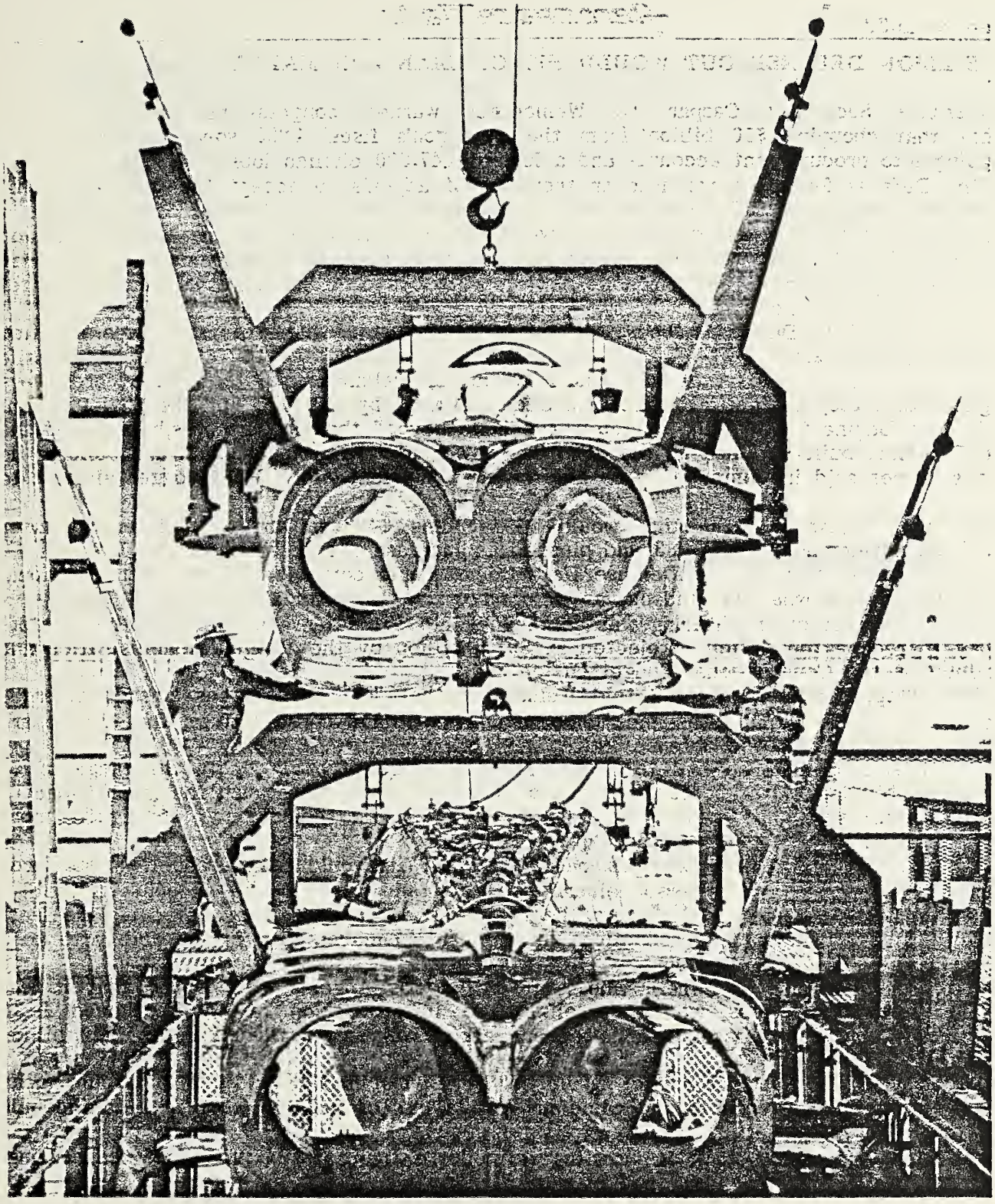
The final decision in favor of the CF-18 over the CF-16 centered on the engine capabilities of the two aircraft.

In announcing the decision, Canadian Defense Minister J. Gilles LaMontagne explained that the Hornet was better suited to Canada's vast geographical distances because its two engines — as compared F-16's one — gave the aircraft an additional margin of safety, which is especially important in Canada with its expanse of uninhabited terrain and harsh winter climate.[192]

"This means that fewer CF-18As should be lost accidently over the life of the fleet," Minister LaMontagne stated. "The forecast accidental losses for the CF-16 are such that initial fleet size advantage would disappear during the life of the NFA fleet," the Defense Minister added in referring to the fact that the $2.34 billion NFA deal would have bought more F-16's than the more versatile and advanced Hornet.[193]

In addition, the greater size of the Hornet made it easier to incorporate improvements to the aircraft during its lifetime and thus offered more flexibility in coping with changing tactical and strategic circumstances. This was an important consideration for the Canadians because the new fighter is destined to stay in service with the Canadian Air Force until the turn of the century.[194]

Final assembly of the CF-18 will be in St. Louis (whereas the (F-16A would have been assembled by former General Dynamics subsidiary, Canadair, in Montreal). The first CF-18 was scheduled to be delivered to Canada in October 1982.



FIRST F/A-18A FOR CANADA is assembled at Northrop Corp.'s Aircraft Div. in El Segundo, Calif. The center and aft fuselage shipset will be sent to McDonnell Douglas in St. Louis—Hornet prime contractor—for final assembly and delivery to the Canadian Armed Forces. Canada has ordered 138 CF-18s. The U.S. Navy and Marine Corps plan to buy 1366, and Australia has announced plans to buy 75.

Source: Aerospace Daily

Building of CF-18 forward-fuselage sections were to be put up for bidding in Canada, with the strong likelihood that McDonnell Douglas of Canada (which occupies the old Avro Aircraft plant) would be the most competitive bidder. Other work packages would also be put up for open bidding in Canada; some would be joint US/Canadian ventures; and others would be license agreements.

Canada's approval of the aircraft was generally considered as making it easier to market overseas, with Australia, Greece, Turkey and Spain among the prospective buyers.[195]

11. The Federal District Court Dismisses the Northrop Suit

The federal district court made its decision in September, 1980 on the Northrop-MDC dispute. The court dismissed Northrop's suit. The decision raised several issues which demonstrated the problems that may arise from such teaming agreements. Northrop was quoted as saying that the issues involved in the court decision are "so fundamental that if the decision is allowed to stand, teaming arrangements between companies will be discouraged to the detriment of national security consideration." While the decision will probably be appealed, and the facts of the case are distinguishable from those of many other teaming agreements, the issues raised in the decision point out the need for great care before entering into teaming agreements and making business decisions based thereon.

The court based its decision in favor of MDC on four grounds:

Non-justiciability of political questions. Basically, the court held that the "complex statutory structure relegating to the Executive Branch...the concerns for the military arsenal—its development, procurement and employment (and foreign sales)" rendered it inadvisable for courts to hear this type of case and become in effect "the super procurer and sales licensor of a military weapons system."

Act of state doctrine. Under the long-held policy that the U.S. courts will not "sit in judgment on the acts of the government of another (country) done within its own territory," the court refused to examine whether McDonnell-Douglas' alledged breaches of the teaming agreement were connected with Northrop's failure to make F-18 sales in various foreign countries.

Indispensability of the U.S. Government as a party to the suit. Northrop alleged that McDonnell-Douglas violated the teaming agreement by disclosing to foreign governments data and technology developed by Northrop. The court held that since the data were developed under U.S. government contracts, and that foreign disclosure required the approval of the U.S. Government, the U.S. Government was an indispensable party to the suit. The court also held that since government approval is required to disclose technical data to foreign governments, under a federal statute, the sole remedy for the owner of the data in the case of wrongful disclosure of that data is sue the United States.

Illegal restraint of trade/monopolization. The court held certain aspects of the teaming agreement to be per se violations of the anti-trust laws as an agreement by horizontal competitors to allocate markets. (Note that the markets involved were foreign governments.) The court denied Northrops' claim that McDonnell-Douglas foreign sales efforts were an "attempt to monopolize" by noting that since the U.S. Government has "absolute and overriding control" of foreign weapons sales, any monopoly is a government monopoly, which is outside the reach of the antitrust laws.

12. The Agreement on the Waiver of Non-Recurring Costs

Canada's Minister of National Defense, J. Gilles Lamontagne went to Washington several months after the selection in July, for a meeting with Brown at the Pentagon. He told reporters afterwards that they expected a proposal from Brown that would reduce the amount of money Canada would pay for F-18 R&D recoupment.

The argument put forward by Lamontagne to Brown and the U.S. press was that, as Canada has a fixed budget of $2.34 billion for the program, cutting R&D costs would mean it could buy extra aircraft. An additional ten was quoted by Canadian officials as a reasonable estimate. This would maximize the number of aiarcraft that Canada would get, they pointed out, benefitting both the North American air defense mission and the NATO mission of the Canadian armed forces.

Canadian officials claimed they wanted the same type of fair agreement that the U.S. government would make with any of its allies and that no favoritism, no special relationship was being sought.[196]

Canadian officials wouldn't say at the time how much money their government would pay to McDonnell Douglas for ten or so extra F-18s. As the R&D situation was still being negotiated, they felt any number would be premature. Others, however, were saying it could be as much as $200 million.[197]

Lamontagne claimed that obtaining some relief on R&D payments would be a boost to Canada's balance of payments with the U.S. on defense items. "We are in the red on exchanges, and with the new fighter, we'll be more in the red." Other officials said that because Canada was buying the CP-140 Aurora aircraft from Lockheed and the F-18 from McDonnell Douglas, "there's a danger that the (situation) could become even more imbalanced." Lamontagne said he told Brown that the U.S. "should make an effort to get a better balance...He didn't agree with (the idea of) more purchases (by the U.S. of Canadian defense items), but he took the point well that (the current situation) can't go on forever..."[198]

Lamontagne, asked about recent criticism of the F-18, said "I'm very confident...I've never lost confidence...I have always taken (the) criticism as not fair to the F-18 or the company (McDonnell Douglas). I know new planes...have bugs and snags, but they will be corrected...I can't see (why) these people are trying to destroy such a good plane."[199]

McDonnell Douglas officials, asked about bulkhead and wing problems with the F-18, said neither was significant. In the case of the bulkhead, cracks were found, but they were in a fatigue test article and were caused by improperly drilled holes. On wing problems, they said engineers postulated a potential flutter at certain speeds and in certain configurations, and to solve it layers of graphite composit were being added. This was to stiffen the outer wing, but also added a little weight. Also helping was the movement forward by five inches of stores pylons, and shifting forward by a similar amount of the wingtip-mounted Sidewinder missiles, officials said.[200]

Some eight months after selection of the CF-18, the two governments were able to reach an agreement on recoupment of previously incurred research and development costs. Defense Secretary Harold Brown and his Canadian counterpart, Gilles Lamontagne, announced on December 17 that they had concluded negotiations on an arrangement by which the U.S. undertook to reduce such non-recurring costs by up to 70 million dollars in exchange for a Canadian government commitment to boost its buy of CF-18s by 8 aircraft, from 129 to 137. This involved the commitment of Canada to match the 70 million dollars waived by the U.S. by an equivalent addition to the defense budget for the CF-18 purchase during the period of the program. The arrangement also enabled Canada to buy up to 20 attrition aircraft without payment of any related research and development charges, established at $877,690 per aircraft if the Canadian government decides to exercise an option in the contract with McDonnell Douglas.[201]

The Pentagon said that, "in arriving at this agreement, such factors as the complete integration of air defense arrangements for North America with its implications for standardization, the long and close relationship existing between Canada and the United States, and the Production Sharing Agreements between the two countries were considered."[202]

The following memo concerning recoupment of nonrecurring cost for the F/A-18 aircraft, was sent by Navy Secretary John Lehman to Deputy Defense Secretary Frank Carlucci on Dec. 14 1981.

> By memorandum of 1 August 1979 the Director, Defense Security Assistance Agency (DSAA) approved a charge of $877,690 for the recovery of nonrecurring costs for each F-18 aircraft sold to foreign countries. That charge was calculated based on certain assumptions about nonrecurring costs incurred, and projected to be incurred, and the total number of aircraft to be produced. The nonrecurring cost was projected to be $1,998,500,000 and the anticipated production run was 2277 aircraft (1377 for the U.S. Navy and 900 for foreign sale.) The unit recoupment charge of $877,690 was applied (and reduced) in the case of the purchase of the F-18 aircraft by Canada and has been used in current discussions with Australia.
>
> Significant changes to the original assumptions have occurred. The nonrecurring cost is now expected to be $2,730,400,000. Furthermore, all the foreign sales do not appear likely to materialize. Rather the sales are not likely to exceed 500 aircraft. Thus the unit recoupment charge should be approximately $1,454,715 on the basis of this current information.
>
> This disparity between the DSAA established nonrecurring recoupment charge and one which will recoup a fair share of our investment illustrates the deficiencies inherent to our present method of calculating nonrecurring cost recoupment. These deficiencies include: (i) establishing recoupment charges long before we know either the actual nonrecurring cost or a realistic sales projection; (ii) failing to adjust the nonrecurring recoupment charge when the original assumptions on which it was based prove erroneous and (iii) disregarding the effect of inflation on the nonrecurring charge, thereby penalizing ourselves and those countries who take the risk associated with buying systems early in production and rewarding those who buy last.
>
> These deficiencies need to be examined and I suggest that DSAA be tasked to examine alternate ways of calculating nonrecurring cost recoupment

which would correct these deficiencies. In the meantime authority is requested to change the nonrecurring cost recoupment charge for the F-18 to $1,454,715 per unit and to use this amount in calculating prices to be provided to the Government of Spain during discussions which are presently in progress and in all future sales of the F-18 aircraft.[203]

13. Issues Raised by the CF-18 Offset Arrangement

By early 1981 McDonnell Douglas was able to report that it and its suppliers have pumped $380 million into Canada as part of the industrial off-set program for Canada'a CF-18 contract. The McDonnell Douglas announcement covered the period between March 18, 1977 and the end of 1980. The Company said the business funneled to Canada was almost double the $193 million contract goal for that period. A McDonnell Douglas spokesman said a "large part" of the off-set contracts concluded in Canada were arranged before Canada selected the CF-18.

Products covered in the report include F-18 machined parts, transmitters, fuse tubes, components and tooling for the McDonnell Douglas DC-9 Super 80 transport, General Electric F404 engine and J79 engine components, castings, forgings, plastics, lighting panels and other parts. Some 252 Canadian firms were involved in the off-set program.[204]

Later that year, in September 1981, officials of McDonnell Douglas addressed a symposium on international co-production, industrial participation and offsets at the Defense Systems Management College (DSMC) in Fort Belvoir, Virginia. The McDonnell Douglas officials suggested that, based on their experience with the Canadian NFA competition, the DoD should reverse its hands off policy on offset arrangements, and lay down at least some ground rules to restrain

bidder wars between U.S. firms over foreign sales, such as that which developed over the Canadian NFA.[205]

In this program, as in the Canadian LRPA (CP-140) program before it, offsets were not granted while directly under the gun of foreign competition, but to best other U.S. defense contractors. It is one thing for U.S. firms to engage in this sort of bidding as a lesser of evils (i.e., share, or get none of the action at all) when facing off against foreign competition. Here it becomes virtually impossible for the contractors to counter the buying government's divide and conquer policy. When the contestants involved are all U.S. firms it's much less palatable to watch work be auctioned off that would have otherwise gone to U.S. subcontractors, whichever U.S. firm won. But then the obvious question arises, if the DoD intervened to enforce such a policy, what would keep the procuring foreign government from ensuring the participation of non-U.S. firms up to the final source selection, so as to avoid the extra U.S. government leverage that would result from such a monopoly?

In any event, the scale of the Canadian CF-18 offset agreement served to fuel the debate within U.S. government and industry over the merits of offsets. Unlike the F-16 sale to the four nation consortium in 1975, there were no foreign competitors amongst the finalists.

McDonnell Douglas officials began to complain soon after contract award of difficulty in meeting their commitments. Reflecting the division in the ranks of the U.S. aerospace industry, McDonnell Douglas suggested at the DSMC

symposium that offsets be restricted to a ceiling of 25-35 percent of the imported value, while General Dynamics recommended against the U.S. Government attempting to set arbitrary limits on offset deals.[206]

Though the CF-18 offset program was not without numerous precedents in both the range of offsets offered and the percentage of the purchase value covered, its size in absolute terms added enough fuel to a long simmering debate to ignite a re-examination of U.S. policy in this area.

In 1981, the new administration established a task force to re-examine the DoD's coproduction policy, and the organization required to best implement it. The task force was set up by the Under Secretaries of Defense for Research and Engineering (USDR&E) and Policy, Mssrs. Delauer and Ilke respectively, and was concerned not only with offset arrangements 'per se', but with the broader issues of technology transfer and the long term impact that these arrangements will have on the U.S. industrial base. There is a feeling in some quarters that this may auger the opening of a new front in the current administration's "get tough" campaign vis-a-vis technology transfer and trade (e.g., steel imports and the pipeline embargo).

An unpublished working paper of the Aerospace Industry Association (AIA) in 1981 stated, "The spectacle of the recent Canadian fighter competition and the success of the 'divide and conquor' procurement policy of the Canadian government establishes a new milestone for others to emulate." The Chairman of the AIA committee that produced the above working, Grumman Internation Co. Vice

President, Fred Raymes, was quoted in the February 20, 1982 issue of National Journal. "Several foreign countries have noted the Canadian government's success and have already revised their modest expectations by becoming significantly more demanding."[207]

H. The Spanish New Fighter Aircraft Competition

On June 23, 1982, NATO's newest member state, Spain, selected the McDonnell Douglas F-18A over the General Dynamics F-16 in yet another run-off between the two fighters (Australia had in the meantime selected the F-18 over the F-16 for a 75 aircraft program involving offsets). The contract was for 84 aircraft (including spares and training) totaling around 3 billion dollars, it was Spain's largest single arms purchase ever. The 84 F-18A's were to replace Spanish McDonnell F-4's and Northrop F-5's, which were also the two F-18 partners.

The competition had originally included the Dassault-Breguet Mirage 2000 and the Panavia MRCA Tornado, as well.

The Spanish government had originally envisioned a buy of 144 aircraft, but it had to reduce the quantity by 60 because of the F-18 price increase and the rise of the dollar vis-a-vis the peseta.

The government's decision had been delayed over a year. A special commission consisting the Ministers of Defense and Industry, plus the head of the Spanish Air Force, had taken four years to make the choice. To quote Le Monde,

> The commission eliminated the Mirage 2000 in order to diversify Spain's suppliers; already possessing the Mirage III and the Mirage F-1.[208] The Tornado seems to have been abandoned for technical reasons, inspite of the socialist party which preferred a European aircraft. The F-16, ... remained the final competitor, but General Dynamics lost the battle, because

it did not offer as much in the way of industrial offsets as its competitor.[209]

Offsets agreed to by McDonnell Douglas include shoe manufacture technology exchange and construction offered to Construcciones Aeronauticas S. A. (CASA) of the following F-18 parts:

- Leading edge extension.
- Leading edge flaps.
- Speed brake.
- Aft fuselage side panels
- Stabilator.
- Dorsal deck covers.
- Rudder assemblies.

McDonnell Douglas officials expect negotiations on the contract to start Sept. 1, 1982 with completion in mid-December.[210]

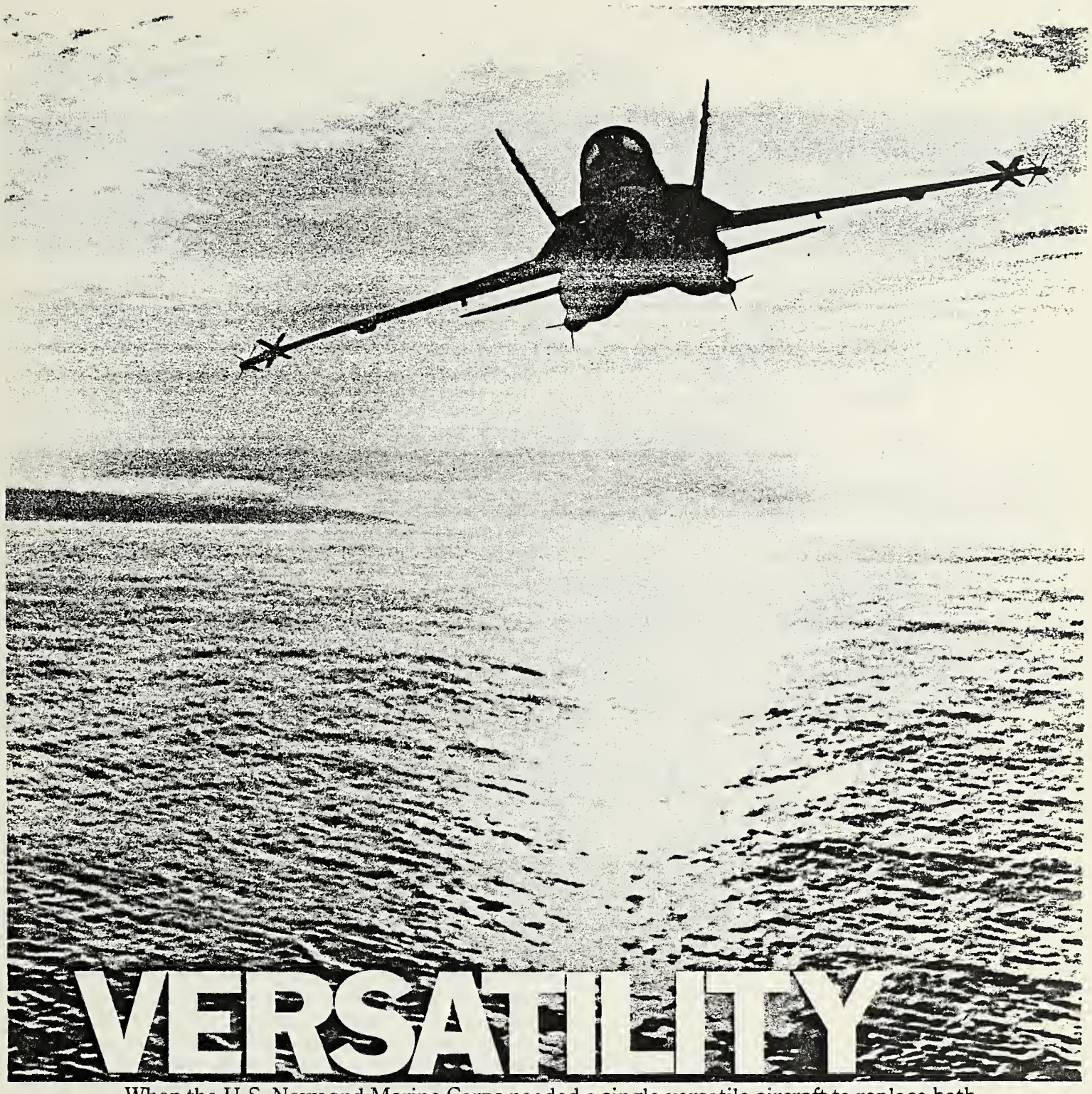
I. Northrop and the 1982 Turkish Fighter Competition

As of mid-1982, offset terms were emerging as a possibly decisive factor in a Turkish competition between Northrop and General Dynamics. For Northrop, the outcome has taken on added importance since the U.S. government turned down a request to sell the F-5G to Taiwan and the company has not yet found another overseas market for the advanced version of the plane.[211]

After the United States lifted its partial arms embargo on Turkey in 1978, Turkey postponed modernization of its armed forces while it grappled with huge foreign debts and an economic crisis. Now, Turkey's NATO-assigned armed forces are moving forward with plans to acquire new equipment that could cost as much as $5.6 billion.[212]

Turkey is giving priority to obtaining sophisticated fighter airplanes to replace planes that are already obsolete, or will be so by 1984. Ankara has reportedly narrowed its shopping list down to F-5s, F-16s and F-18s. The U.S. government has authorized $400 million in foreign military sales credits for Turkey, but this alone will not make it possible for Turkey to cover its needs.[213]

This was the problem uppermost in the minds of members of a Northrop commercial team that spent almost two months in Turkey in April and May 1982 interviewing officials, businessmen, and trade associations in order to take an inventory of Turkish companies with export potential.[214]



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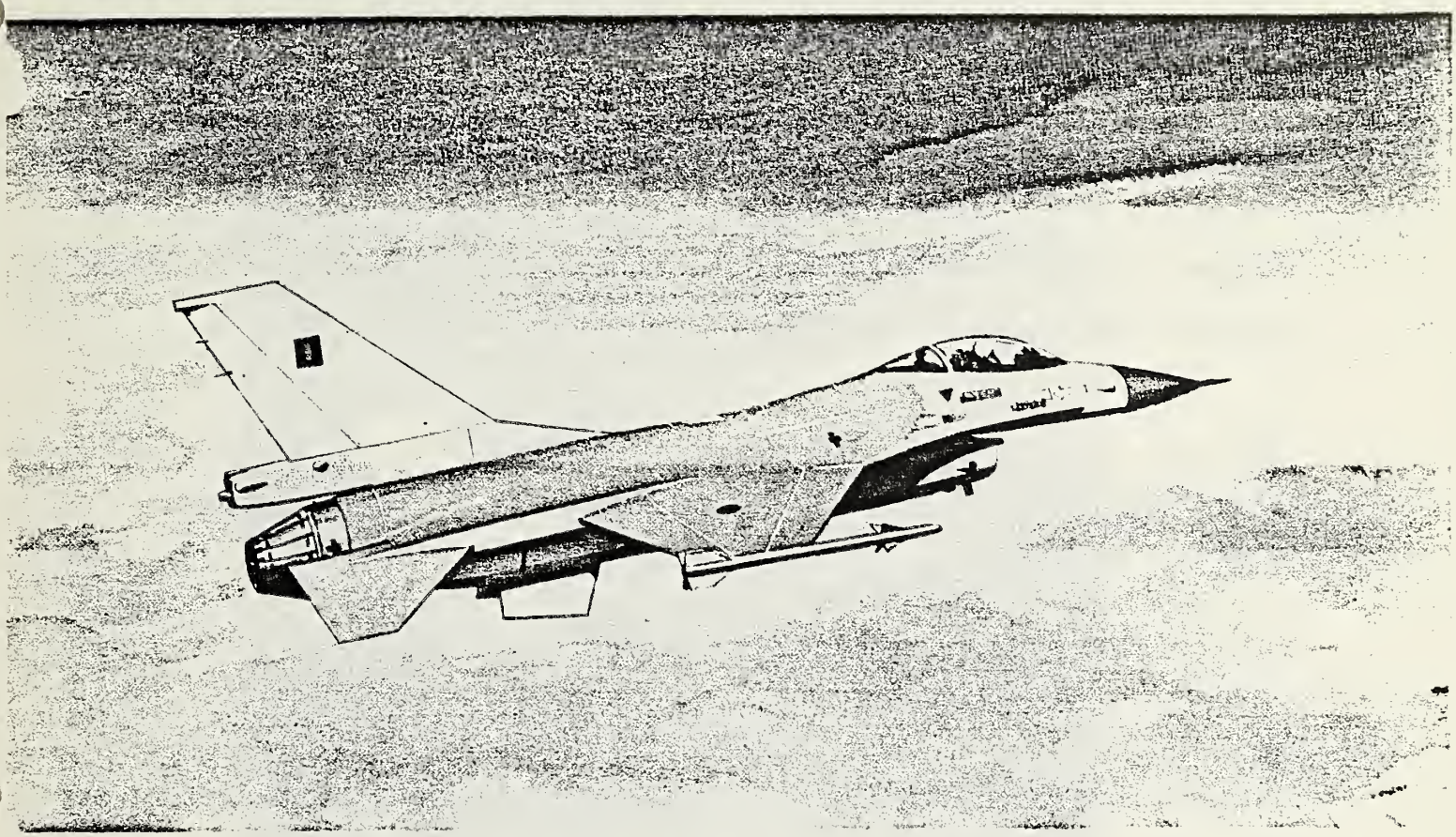
© 1980 Northrop Corporation

Much like the Swiss F-5E sale of 1975, under a proposal that Northrop is working out, the company would guarantee to find markets in third countries for tens of millions of dollars' worth of Turkish wine, refrigerators and other products, in return for Turkey's selection of one of Northrop's planes, either the F-5G or the F-18L, over the General Dynamics F-16 or the McDonnell Douglas F-18A.

As part of this effort, officials of Northrop spent a day visiting vineyards, inspecting wineries and sampling the pleasant local vintages that are little known outside the country.[215]

In addition to promoting such items as wine and refrigerators, Northrop officials say they have told Turkish construction companies about projects in Nigeria and Saudi Arabia that could earn money for Turkey and might count as offsets against plane purchases. Northrop's role, officials stress, would not be to buy the wine or refrigerator as payment for planes, but to locate a foreign merchant who might want to import it.[216]

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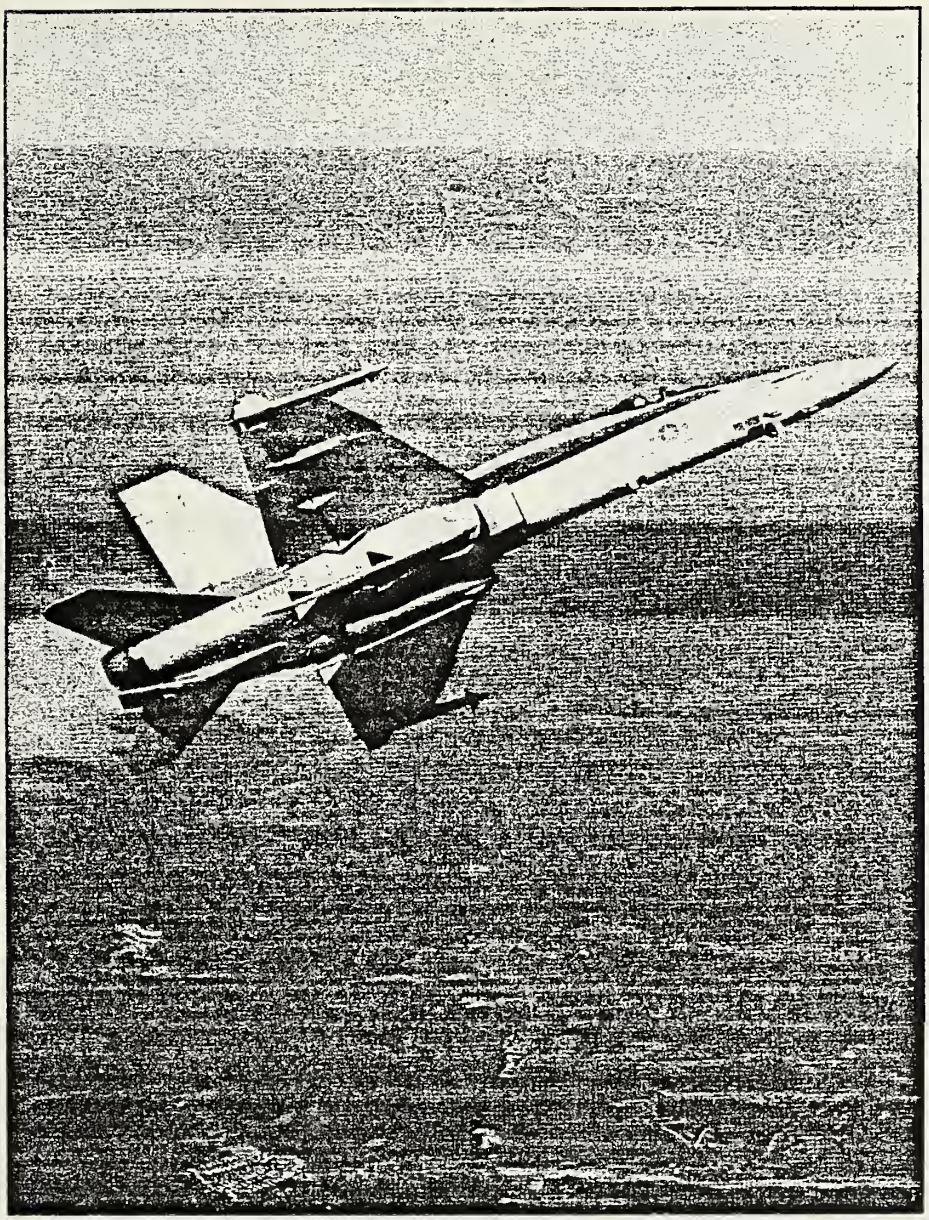
Greek defense officials visited several Western nations during the Spring of 1982 to evaluate combat aircraft in preparation for a decision later in the year or early 1983 on the selection of a new fighter for the Greek Air Force.

Fighter candidates heading the list include the General Dynamics F-16, McDonnell Douglas F-18A, French Mirage 2000 and the British/German/Italian Tornado.

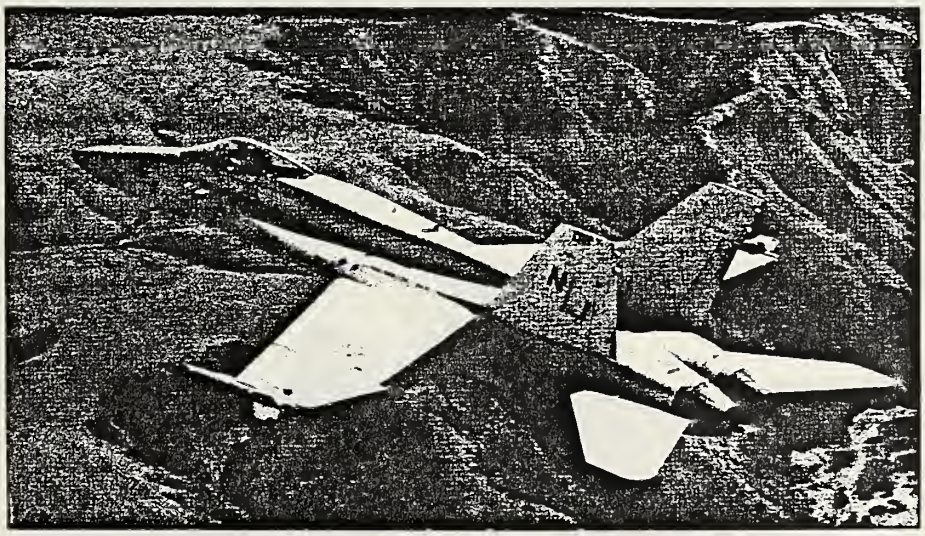
Any selection of the new fighter will be linked to favorable arrangements for military coproduction, which would be centered around the Hellenic Aerospace Industry.[218]

Panavia made its first Tornado proposal to the Hellenic Air Force in 1980 for 60 aircraft. In 1981, a team from the Air Force New Fighter Aircraft Committee conducted a detailed flight and ground evaluation of the Tornado. Evidently, the former Greek air chief of staff in 1981 recommended the Tornado as the aircraft required to meet the Greek Air Force's future aircraft needs, but the Greek gov-ernment asked for a new evaluation after Andreas Papandreou became prime minister and defense minister in the fall of 1981.[219]

With the competition reopened, Panavia Aircraft GmbH offered Greece an offset package valued at $850 million to $1.7 billion in May 1982, to encourage Greek selection for the Tornado multirole combat aircraft (MRCA) as its future fighter.[220]



Blickfang: Die Außenlasten der F-18 erlauben eine präzise Ortung mit dem Radar



Schokoladenseite: Von oben und von der Seite gibt es wenig Reflexionsflächen

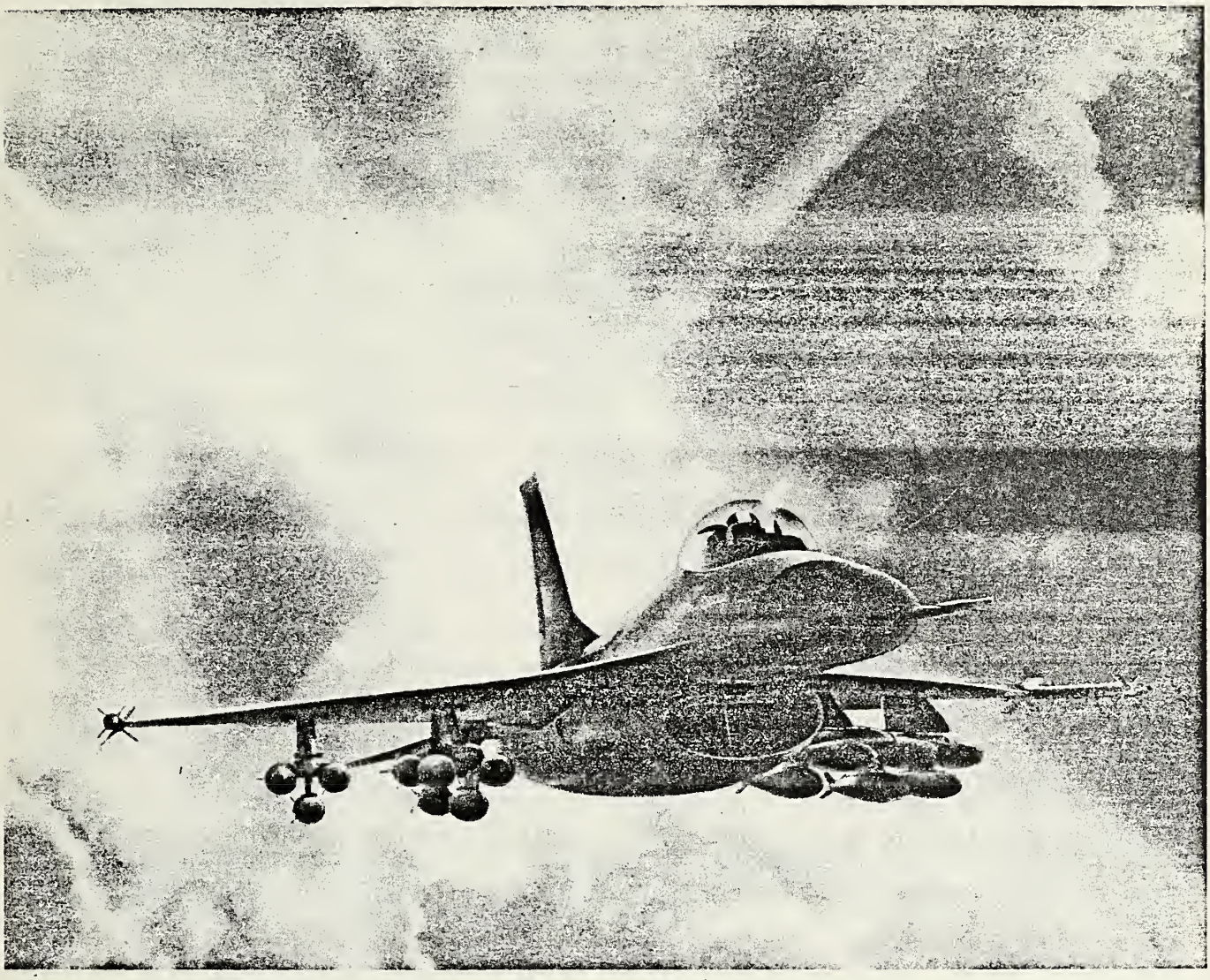
Panavia's 100% offset package was based on a buy of 50-100 aircraft. The package was outline to the Greek minister of state for national defense, Georgios Petsos, who was in Germany in early May, 1982. Petsos toured the trinational facility in Munich, where the proposal for the Greek new fighter program aircraft was discussed.[221]

Panavia is offering 100% offset of the total possible contract value and partnership status for Greece in the Tornado program, including direct access to the technological skills of Panavia's partner companies, Aeritalia, British Aerospace and Messerschmitt-Boelkow-Blohm (MBB).[222]

During his visit, Petsos discussed details of the Panavia offer with representatives of the Panavia consortium, including Gero Madelung, chairman of the Panavia board of directors and also of MBB.[223]

The offset package includes coproduction of the Tornado with the Hellenic Aerospace Industry, cooperation between Panavia and its consortium partners and subcontractors with Greek industry in other aerospace and defense industry projects, and joint ventures in nondefense-related projects. A decision by the Greek government to acquire the Tornado would lead to:

- Manufacturing and assembly of components for the aircraft in Greece, along with test and repair of the Turbo-Union RB. 199 engine. Avionics capability also would be transferred to the Greek aerospace industry.

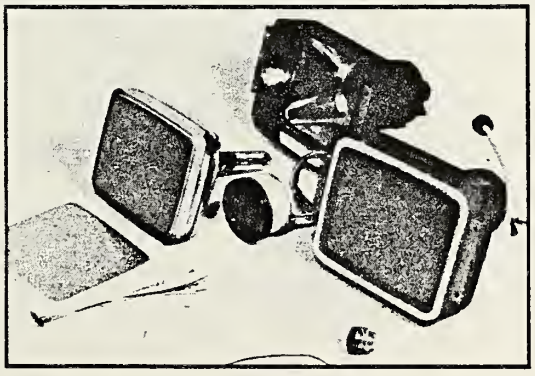


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- Transfer of other defense industrial capability to Greece, including manufacturing of ship mines and antitank weapons.
- Support of and assistance in selection of a new trainer aircraft for the Greek air force.
- Transfer of solar and wind energy technology.
- Installation of liquid gas pipelines in Greece.
- Improvement in Greek fish farming capability.[224]

Panavia also offered to assist in Greece's agricultural development, while promoting Greek products on the world market and fostering tourism.[225]

During a lightning visit on April 23, 1982, the French Socialist Defense Minister, Charles Hernu, flew into Athens and signed a Memorandum of Understanding (MOU) with his counterpart, Andreas Papandreou (who is also Prime Minister, holding the defense portfolio as well). The MOU was to provide a framework for Franco- Greek cooperation in weapon system procurement. Under negotiation since November 1981, one month after the Greek socialist party came into power (after a heavily anti-American electorial campaign), and discussed principally with the Greek secretary of state for defense, Georges Petsos, the framework MOU was to further the growth of the Greek aerospace industry though recourse to French technology for production of equipment, and direct purchase from France.[226]

It was within this framework that commercial discussions began between Dassault-Breguet and the Greek government, over the French entry in the new fighter aircraft competition, the Mirage 2000 fighter plane.

The Franco-Greek MOU has attempted to address the problem of how Greece is going to be able to sustain the major defense procurement effort underway. The plan is to attack the problem from two angles. One, involves the development of its own defense industry, and the other focuses on a reduction in costs by grouping and planning procurements so as to eliminate the usual costly intermediaries. France, for its part, plans to assist by contributing to the development of the naiscent Greek armament industry.[227]

The MOU signed in Athens does not presuppose a privileged position for France in the current and up-coming negotiations, but, will no doubt further contribute to the close working relationships that the two recently elected socialist governments are actively seeking to nurture.[228]

As the heat of the competition rose, in October 1982, Panavia offered a more detailed and generous offset proposal to the Greek government.[229] Under terms of the revised proposal, Panavia and other companies associated with the Tornado program agreed to assist Greek companies to:

- Perform final assembly of both the airframe and the Turbo-Union RB. 199 engines powering it for the 60 aircraft purchased by Greece.

- Build airframe and engine components, avionics equipment and ground support equipment for all Tornado aircraft produced after the agreement is signed.
- Produce a variety of modern munitions under subcontract from Mauser, which builds the Tornado's guns.
- Coproduce and assemble either the Messerschmitt-Boelkow-Blohm Kormoran antiship missile or the British Aerospace Dynamics Skyflash missile, or both, if the missiles are selected to arm the Tornados.
- Participate in a joint venture program for integration of advanced weapons systems, including radar-guided antiaircraft artillery. One of the primary systems integration companies in the Tornado system would provide training and technology transfer for the program.
- Build one of three trainer aircraft selected by Panavia, with Panavia to provide worldwide marketing support. The three aircraft under consideration are the British NDN Firecracker, the West German Flugzeug-Union-Sud Flamingo and the Rhein-Flugzeugbau Fantrainer.
- Obtain increased capacity to overhaul gas turbine engines.
- Obtain training, technology transfer and support in developing an aircraft tire retread facility in Greece.
- Receive assistance in devloping a Tornado overhaul and repair facility for aircraft sold to other nations, as well as Greek participation in the future Tornado sales program.
- Establish an ejection seat and safety equipment overhaul facility in Greece.[230]

In addition, Panavia expanded its offer to provide assistance in an additional energy-related program, i.e., the provision of hard coal supplies; also environmental programs, such as recycling of used plastics; development of an aluminum production facility; and other non-aerospace projects.[231]

These would include in addition to those previously offered, the development of a ship-breaking yard.

Panavia studies indicated that by the year 2000 the aerospace- and defense-related portions of the proposed offset plan would return to Greece more than 50% of the cost of the Tornado procurement and the non-aerospace portions would more than double this total, effectively providing the Greeks with about 120% offset on the purchase of the Tornado.[232]

With the political overtones of this source selection clear, and the limits to which the Tornado participants and France are willing to go, McDonnell Douglas, Northrop, and General Dynamics, all face an uphill battle, especially as they have already strained their capacities to absorb new industrial partners by the extensive offset deals worked out with their initial foreign customers.

K. France and Its AEW Requirement

France was a low-key participant in the NATO subgroupings exploring a common solution to the NATO Airborne Early Warning and Control requirement from 1970-78, but in the end, opted not to commit itself because of: implications vis-a-vis the NATO command structure; assessment that a nationally owned system was required that would permit the operational flexibility to cover the Atlantic and Mediterranean approaches to targets key to its nuclear strike forces, plus meet substantial overseas commitments; insufficient work content for France; and a perception that the E-3A was too sophisticated for France's needs.

What the French Air Force felt it needed at that time was simply a flying radar platform that would allow it enough warning time to be able to set off the trip-wire of its nuclear strike forces in case of conventional attack on France, while offering some operational flexibility for overseas deployments; i.e., not a full blown command and control system. Starting in 1977 France decided to re-examine the E-2C Hawkeye as a more limited system that appeared to be at least roughly in line with France's operational performance needs, a system which the NATO Air Force had rejected in 1974 as not sophisticated enough to meet NATO's needs. The E-2C became the front runner and demonstration flights finally took place in 1980 and 1981.

The Grumman Company invited a small group of French journalists in late November, 1981 to its Bethpage, Long Island plant, where the E-2C Hawkeye is assembled. The objective was to present the aircraft (and the concept upon

which its utilization rests), demonstrate the diversified nature of the firm's activities, as well as its commitment to seeking out closer relationships with the French aerospace industry and concluding agreements with other sectors of French industry.[233]

Within the framework of this effort, simultaneously with the announcement in France, it was announced that an important contract representing a piercing of the U.S. market by the Ariane launcher was signed. A representative of Arianespace, present at Bethpage, underlined the significance of this event and the role played by Grumman in it. He recognized that at the time of Arianespace's establishment 18 months ago, the idea of orders ever coming from the U.S. was simply unthinkable. He attritubed the success of Grumman's effort to the American contractor's knowledge of space and of the potential launcher market in the U.S.[234]

In the specific area of aeronautics, Grumman has already had, or soon planned on having, contacts with French industrialists. Certain among them have been offered possible deals (e.g. Thomson-CSF, Crouzet, and Turbomeca). Others, such as SOGERMA, were reportedly interested in maintenance work associated with any eventual French government order of the Hawkeyes.[235]

Until the fall of 1981 the French had been considering only the Hawkeye and two systems which would involve "Nimrod-type avionics" (i.e., the Marconi radar system) installed on French-built airframes; either the Aerospatiale C-160 Transall cargo/troop transport or the Dassault-Breguet Atlantic Maritime Patrol

Aircraft. Neither of the Franco-British systems could be deployed before the end of the decade and both were more expensive than either of the American systems.

In January 1982, the French government changed directions and asked Boeing for proposals for three, four, or six AWACS aircraft. Boeing responded by sending pricing and availability data to France on March 15.

Boeing demonstrated the E-3A for the French Air Force in a series of flights in June and July based out of Mont-de-Marsan in South Western France. To quote an article by Jacques Isnard entitled, "An Enthralled French Air Force: the Boeing AWACS Demonstration at Mont-de-Marsan," in the July 17, 1982, issue of Le Monde, page 7.

> The French Air Force is particularly satisfied with the results of the recently completed demonstration flight of a Boeing AWACS E-3A radar plane involving technicians from its base at Mont-de-Marsan.
>
> "We searched in vain for gaps in its detection capability," admitted one high ranking officer who flew on the radar plane, "but who also fears...that extremely strong praise might diminish the manufacturer's incentive to make financial concessions in the event of contract negotiations.
>
> Flying over Dijon, the AWACS detected airplanes that were concealing themselves by weaving through alpine valleys. North of the Balerics, above the Western Mediterranean, the same plane was able to detect aircraft taking off from the Maghreb North Africa , in Italy, and even as far away as Yugoslavia. Few incursions by intruders apparently escaped its scan. . . .
>
> With a great deal of discretion, the Pentagon let it be known that, taking into consideration the importance of a possible French order, the U.S. could consent to the granting of certain benefits, without straying too far from the price paid by the

NATO countries. NATO will receive up through 1986, 18 Boeing AWACS stationed principally in the Federal Republic of Germany, Greece, Italy, Turkey, and Norway.

The aircraft, an Air Force Systems Command R&D model stationed at Boeing's Seattle plant, was loaned to Boeing for the tests and manned by a Tactical Air Command crew and Boeing personnel. According to French military officials, the French Air Force in early August was looking over tapes from the flights and "evaluating the plane's performance against its own defense requirements." Pentagon officials confirmed reports that the French Air Force was leaning towards the plane.[236]

But Pentagon officials stressed that French economics and political factors may prove more important to the sale than costs. "The strength of the dollar isn't helping any," one official said.[237]

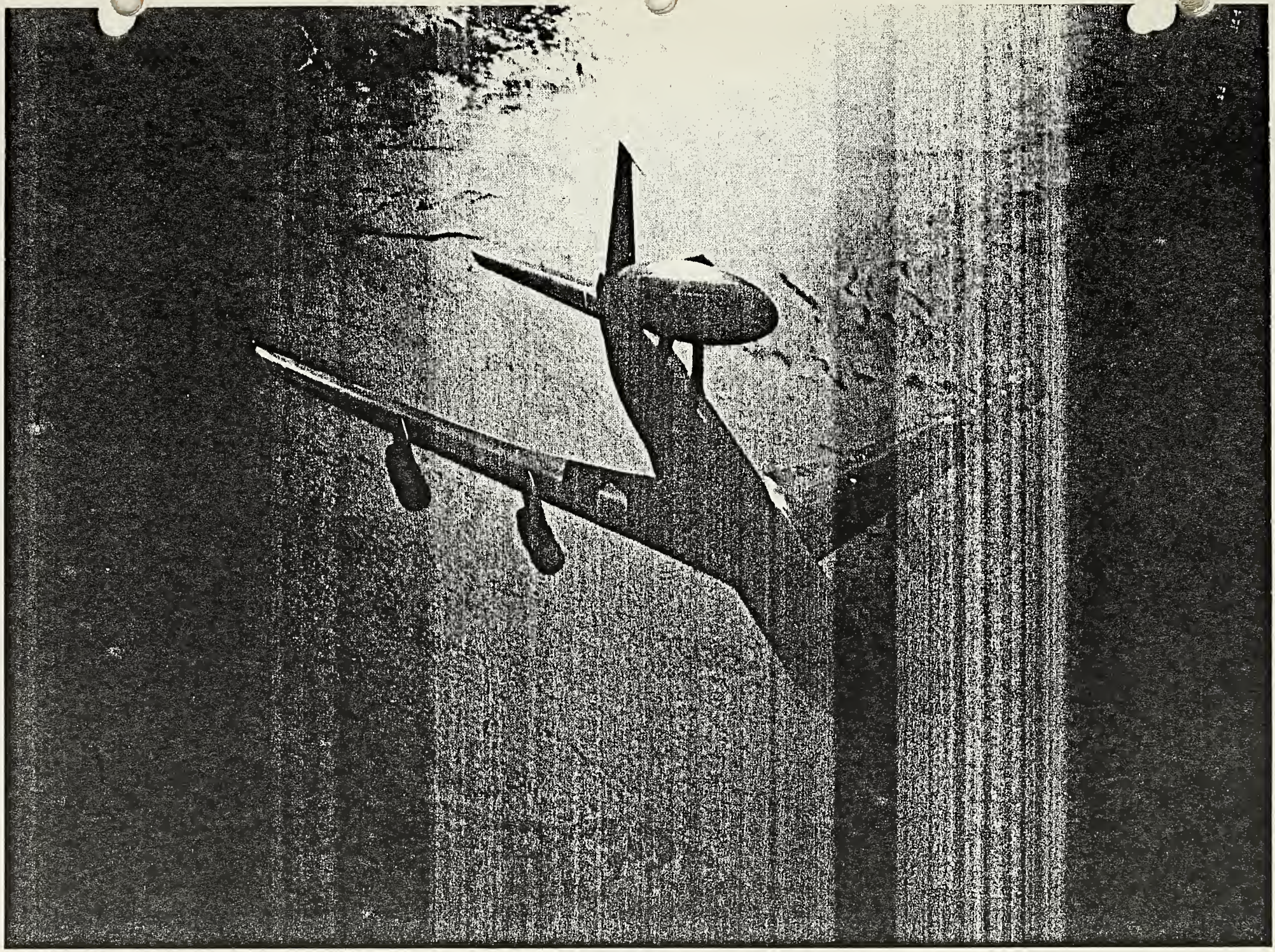
More importantly, the political differences between France and the U.S. were seen to be easing. Pentagon officials said a major U.S. policy change was in the works, one that would ease U.S. opposition to the natural gas pipeline to be built from Siberia to Western Europe. "There is a growing realization of how important France is to defense," one said, "German defenses are thin—if the Soviets made a conventional strike, they would be in France before any one knew what was happening." America's chief NATO allies, including the United Kingdom, Italy and the Federal Republic of Germany, have joined France in criticizing U.S. attempts to obstruct the building of the pipeline.[238]

U.S. military officials pointed out that for NATO defense, the AWACS had the advantage of longer range and more time on target, as compared with the E-2C.[239] A final decision between the E-2 and E-3 was expected by early 1983.

On June 1, 1982, Boeing submitted its E-3A offset proposal to the French Government. The proposal pointed out Boeing's history of procurement from French sources, promoting of French designed systems (e.g., Excocet and Roland), and in particular its important role in the success of the CFM-56 engine.

The CFM-56 engine is a 50/50 joint venture between France's SNECMA and General Electric. Boeing has promoted the CFM-56 through its 707/CFM-56 certification program, (and thereby can offer it for the FAF E-3A's) the USAF/French Air Force KC-135 reengining (currently only 10 aircraft under contract but a strong probability of at least 300 aircraft (of total of the USAF 600 KC-135's) and all 11 of France's C-135F's), the 737-300 program which is utilizing the CFM-56, and most recently its ECX, submarine communications aircraft being proposed to the U.S. Navy by Boeing. Boeing also outlined work packages to be offered on the E-3A by major subcontractor Westinghouse, and other Boeing Aerospace Company missile, aircraft and space projects, if France selected the E-3A.

On July 27, 1982 Boeing held a symposium to elaborate further on Bid Opportunities to French industry tied to the procurement of E-3A's by the French Air Force at the GIFAS Aero Club de France in Paris. Later in 1982 and



E-3A

AIRBORNE WARNING AND CONTROL SYSTEM

early 1983 Boeing teams completed a survey of some 55 French aerospace firms as part of the AWACS offset paln.

Once again the decision slid. In October 1983 though, the E-2 was eliminated from the competition and an FMS proposal/pricing began shortly thereafter for the acquisition of three AWACS.

In January 1984 Boeing announced the award of a contract to CFMI, including $78 million in French offset for CFM-56 engines content for a foreign customer. A new offset paln detailing the work was issued by Boeing in June , packages from the AWACS as well as other Boeing projects and divisions which were to meet offset requirements of the French government. By mid-year bottom line negotiations had resulted in several moves by Boeing culminating in an agreement to: a commitment of 35% by two years after delivery of the last aircraft; with an objective of 50% by five years after delivery.

L. Conclusion

As the U.S. Government's policy towards cooperation with our European allies in arms procurment has blown hot and cold over the last third of a century since NATO was setup, the European allies have moved towards greater self-reliance. While continuing to cooperate, as they have assumed a greater share of the burden, the European's have demanded a greater share of the work. As covered earlier in this chapter, the constituent social democracies of the North Atlantic Alliance must assure that the tax payers back home get their share of the benefits, if they are to support the burden of maintaining their respective national defense efforts. By no means is this phenomenon unique to the arms trade, but given the relatively few, but large scale government acquisitions involved, the international product cycle wherein production is eventually shifted over to the consuming nations (at the origin of the existence of multi-national corporations, see chapter 14), it occurs much more rapidly than with comsumer products and non-defense capital goods. Moreover, given the endemic overcapacity problems of all the national defense industries on both sides of the Atlantic and the high powered support that most governments provide for their competing systems; is there any wonder it's a buyer's market?

Even though the impact of these developments on the U.S. industrial base (especially at the lower tiers) is highly unfavorable, the ability of any government to regulate these forces, either unilaterally or within some multi-lateral framework, is severly limited. The recent atempt of the DoD to define its policy in the area of inter-allied collaboration and to reorganise so as to be able

to more closely monitor and coordinate U.S. industrial activities, is laudible. One might hope, however, that futile and dangerous tendencies toward unilateral control of this process and the punishment of recalcitrant allies will be held in check.

In its understandable efforts to avoid, or at least minimize, the recurrence of offset programs similar to those with the Canadian government over the CP-140 maritime patrol aircraft and the CF-18 fighter, one has only to look at the Dutch German agreement over the Leopard II, and the more recent Greek and Turkish fighter competitions, to be freed of any illusions over how far the U.S. can go in this direction. Foreign governments will simply avoid ever reducing the list of finalists to a U.S. systems only run-off.

Mode #6 of industrial collaboration, upon which this chapter focuses, is generally the least preferable when selecting Modes of industrial collaboration. From a rational ecomonic point of view, Modes 3, 5, or 8 of joint design and development, or Modes 1, 2, 4 and 7 of joint production, are usually preferable to the Mode #6, when they are feasible options. However, due to the size of the requirement or the timing of the procurement very often they are no longer feasible or at least cannot provide politically acceptable offset work packages in of themselves. In the latter case they often have to be complimented by resorting to bi-lateral offsets in addition to the primary Mode of industrial collaboration, e.g. the Belgian HELIP add-on, or the FRG with the NATO AWACS project.

These bi-lateral barter-like agreements offer a full range of options as summarized on pages 3 and 4 of this chapter, and spelled out in detail by the individual projects covered herein.

It is easy to point out the inefficiencies of such agreements and the fact that they cut against the grain of free trade, which are both undeniably true. In a scenario where its always lesser of evils, however, this Mode of industrial collaboration will continue to provide the necessary glue for the cementing together of many of the inter-allied arms deals.

[1]With the closing of the gold window of the U.S. Treasury and the shift from the Gold standard to a floating exchange rate system in 1971-3, this became less important. Because of this factor and an evolution of the attitude in the FRG these offset agreements ended in the early 1970's.

[2]Several major projects involving license production in Canada of U.S. fighters are treated briefly elsewhere in this paper: the F-86 Sabre during the early and mid-50's in Chapter 5; the F-104 Starfighter during the late 50's and early 60's in Chapter 7; and the CF-5 in the second half of the 60's and early 70s in Chapter 6. The evolution of the overall U.S.-Canadian development and production relationship is covered in Chapter 5 and Chapter 10. More recently, major projects involving production sharing between the two nations have tended to be offset arrangements, and are therefore treated in this chapter: the purchase of 9 CH-47 Chinooks (CH-147), 18 CP-140 maritime patrol aircraft, and 137 CF-18 fighters.

[3]Herbert J. Coleman, "British Phantom Cost Doubled with Switch to Spey Engine," "Aviation Week & Space Technology, August 19, 1968.

[4]The UK originally projected an order of 292 F-4's, but as it turned out, as a result of a policy of Anglicization, i.e., introducing indigenous avionics equipment and the Rolls Royce Spey engine, only 170 were ordered. Initially 50 were to be for the Royal Navy and 120 were for the RAF. However, with the decision in late 1967/early 1968 to scrap her aircraft carriers and disband the fleet air arm, this distribution was changed with only 28 going to the Royal Navy, and the rest being for the RAF. The Ark Royal was being refitted to take the remaining 28 Royal Navy Phantoms at a cost of $80 million.

[5]Coleman, op. cit.

[6]Herbert J. Coleman, "Massive Budget Rollback Slices British Power; F-111K Canceled," Aviation Week & Space Technology, January 22, 1968, p. 17.

[7]Ibid., p. 18.

[8]Coleman, "...Phantom Cost Doubled...", op. cit.

[9]Ibid.

[10]John Stanley and Maurice Pearton, The International Trade in Arms, Praeger Publishers for the Institute for Strategic Studies, London, 1972, p. 107.

[11]Ibid., pp. 108-9.

[12]Ibid., p. 109.

[13]Ibid.

[14]Ibid., p. 110.

[15]George Thayer, The War Business: The International Trade in Armaments, New York, Simon and Schuster, 1969, pp. 229-232.

[16]Coleman, "Massive Budget Rollback...," op. cit., p. 17.

[17]Ibid.

[18]This estimate of savings is based on the British estimation of cancellation charges of $120 million, but the DoD was simultaneously quoting a figure of around $300 million.

[19]The DoD had previously been informed of a probable 10-15 aircraft cut in the F-111K order, but had been assured that a complete cancellation was not con-

templated. Defense Minister Healey was, however, forced to eat his words after losing a hard fought battle with his cabinet colleagues.

[20]Coleman, "Massive Budget Rollback...," op. cit., p. 19.

[21]Herbert J. Coleman, "U.K. Aerospace Exports Near Peak", Aviation Week & Space Technology, September 16, 1968, p. 26.

[22]Ibid.

[23]This figure was orignally $100 million, but the Germans threw in a last minute demand for an increasse that upped it by $25 million.

[24]Arnold M. Berry, Captain, USAF, and Edward A. Peterson, Captain, USAF, RF-4 Coproduction: United States and Federal Republic of Germany, a thesis presented to the Air Force Institute of Technology (AFIT), January, 1975, pp. 39-40 and 49-50.

[25]Aviation Week & space Technology, "Germans Seek RF-4E Subcontract Guarantees," November 4, 1968, p. 22.

[26]It is interesting to note, as pointed out by Berry and Peterson, that although the agreement between the governments of the U.S. and the FRG indicated the willingness of General Electric and McDonnell-Douglas to take certain actions in support of the agreed to offsets, neither firm signed the agreement nor did they make a written agreement with the U.S. Government. The U.S. Government was legally totally on its own.

[27]Aviation Week & Space Technology, January 29, 1968. p. 28.

[28]This total required F-4 order level was actually exceeded by a considerable margin several years later, but too late for the exercising of this option. This involved an additional F-4 order by the FRG in 1971 of 175 of the F-4F version of the Phantom to fill the ever expanding gap prior to the MRCA Tornado becoming operational.
This purchase was the major purchase helping the FRG to fulfill its troop-offset commitments to the U.S. during the period of 1971-73.

[29]Aviation Week & Space Technology, May 20, 1968, p. 29.

[30]"Luftwaffe Rejects Mirage 3R, Continues Push for RF-4E's," Aviation Week & Space Technology, September 2, 1968, p. 21.

[31]"U.S. Pressure Against European Fighter Seen," Aviation Week & Space Technology, January 13, 1969, p. 20.

[32]Edward H. Kolcum, "RF-4E German Offer Bolstered," Aviation Week & Space Technology, October 28, 1968.

[33]Ibid.

[34]"Germany to Offset 75% of U.S. Troop Costs," Aviation Week & Space Technology, July, 1969.

[35]Ibid.

[36]Ibid.

[37]Ibid.

[38]"U.S., West Germany Reach Offset Agreement," Aviation Week & Space Technology, July 21, 1969, p. 16.

[39]Edward H. Kolcum, "RB.199 Picked for MRCA; GE Leads in A-300B Race," Aviation Week & Space Technology, September 8, 1969.

[40]"U.S.-, West Germany...," p. 16.

[41]Ibid.

[42]U.S. also was discussing awarding the German industry overhaul and maintenance contracts for Spanish F-4's if the U.S. agreed to provide this aircraft to Spain as part of the payment for American bases there. The Spanish base negotiations were still under way, at the time, and never did lead to a Spanish F-4 acquisition. ("German CH-53 Procurement Price Climbs," Aviation Week & Space Technology, November, 1968, p. 28.

[43]"Two German Companies Win F-4 Subcontracts," Aviation Week & Space Technology, June 16, 1969, p. 24.

[44]Berry and Peterson, op. cit., p. 85.

[45]72.31 M of this figure was from orders placed by McDonnell-Douglas under its 1968 and 1971 bid packages. The following month the FRG finally compromised with the U.S. and accepted $20 M of a total of $64.04 M worth of orders as creditable. These orders were placed by the German Government with German industry for support of the RF-4E under a General Electric license to Motoren and Turbinen Union (MTU) for the manufacture of jet engines, and a Litton license with its German affiliate LITEF for navigation systems.

[46]Berry and Peterson, op. cit., p. 96.

[47]This in turn had been preceded by another shift a year earlier. The DoD had originally seen the matter as a purely industrial affair, but as a result of the October-November 1968 negotiations with the FMOD, the DoD agreed to use it's "best efforts" to have those U.S. firms associated with the RF-4 select items for competitive subcontracting to the German aerospace industry, with the objective of placing up to $125 million in orders over the period 1969-1972 (later extended).

[48]The German Federal Association of Aerospace Industries, which was the designated coordinating agency for the German aerospace industry. In the FRG such 'spitz' or 'peak' associations enjoy a quasi-governmental status.

[49]Berry and Peterson, op. cit., p. 95.

[50]Ibid., pp. 31-32.

[51]Ibid., pp. 93-94.

[52]Ibid., p. 60.

[53]ibid, pp. 98-99.

[54]Ibid., pp. 99-100.

[55]It must be remembered that the Leopard I was the result of the German half of the joint Franco-German tank project (1958 - 1963), covered in Chapter 8. The French half, the AMX-30 has relied on extra - NATO sales for its export success. The only other NATO army to procure the AMX-30 was the Greek Army. The French were greatly assisted in this sales effort by the U.S. arms embargo with Greece following the 'Colonels' coup d' etat of 1967. This sale was also accompanied by the awarding of AMX-30 production sub-contracts to Greek industry.

[56]Stanley and Pearton, op. cit., pp. 118-119.

[57]Ibid., p. 119.

[58]Ibid.

[59]One firm that has continually played a large subcontracting role in this regards is the fully nationalized firm, Aerospatiale.

[60]NATO Standardization and Licensing Policy-Exploratory phase, Vol. III: Supplement, Hoagland, MacLachan & Co. subcontractor to General Research Corp. November, 1976, p. 48.

[61]It must be remembered that Dassault's approach to aircraft development has involved a concentration on performance parameters and physical characteristics of moderate complexity, being mindful of carrying out new R&D only on an incremental basis. As a consequence successive aircraft do not represent full generations (GRC/Hoagland, MacLachan & Co., op. cit., p. 46).

[62]GRC/Hoagland, Malachan & Co., pp. 46-47.

[63]Ibid., p. 47.

[64]Ibid., pp. 47-48.

[65]See chapter 5.

[66]See chapter 13.

[67]See chapter 8.

[68]"The Atar 9 turbojet powered the Mirage III and 5, the Mirage F.1 and the Mirage IV bomber. The engine was designed by the 'Atar group' (Atelier Aeronautique de Rickenback) during the 50's. The Atar group was made up originally of a core of German scientists headed by the former technical chief of BMW, Hermann Oestrich, and was later absorbed by SNECMA.

[69]Belgian Buy Spurs Mirage Sales" Aviation Week & Space Technology, Feb. 26, 1968, p. 16.

[70]Ibid.

[71]Ibid.

[72]Edward H. Kolcum, "Europe Revises Strategic Planning Bases" Aviation Week & Space Technology, March 9, 1970, p. 51.

[73]Belgian Buy Spurs Mirage Sales, op. cit., p. 17.

[74]Edward H. Kolcum, "Europe Revises Strategic Planning Basis," Aviation Week & Space Technology, March 9, 1970, p. 53.

[75]Edward H. Kolcum, "Loan Approval Delay Caused U.S. to Lose Fighter Order," Aviation Week & Space Technology, April 13, 1970, p. 20.

[76]Ibid.

[77]Ibid.

[78]Ibid.

[79]"Belgian Buy Spurs Mirage Sales," Aviation Week & Space Technology, February 26, 1968, p. 16.

[80]Stanley & Pearton, op. cit., p. 120.

[81]"Czech Invasion Bares NATO Atrophy," Aviation Week & Space Technology, March 10, 1969, p. 85.

[82]Martel Ship - Launched Version Designed, Aviation Week & Space Technology, September 7, 1970, p. 81.

[83]Over 450 Olympus turbines had been sold as of mid-1980. Originally developed in the 1950's for the Vulcan bomber and later modified for the use on the Concorde, its greatest use has been on ships and commercial power plants.

[84]John Marriott, NATO's 15 Nations, Oct/Nov. 1976, p. 82.

[85]Richard F. Coburn, "Swiss Aircraft Industry Declining," Aviation Week and Space Technology, June 29, 1970, p. 51.

[86]Louis Kraar, "Everyone at Northrop is in Marketing," Fortune, April 10, 1978, p. 54.

[87]Dan Morgan, "Acting as Middleman for Exports, Northrop Boosts Its Sales Abroad," International Herald Tribune, July 7, 1982.

[88]Kraar, op. cit.

[89]Ibid.

[90]Morgan, op. cit.

[91]"Belgian Company Gets $8.5 Million for Machine Guns," Aerospace Daily, September 24, 1979, p. 101A.

[92]Fabrique Nationale had originally expanded into the U.S. back in mid-1977 when it took over the Utah based Browning Arms Co. At the time when FN was involved in negotiations with the U.S. Army in 1975 over the Mag-58, Browning and FN were both under investigation for having fudged in U.S. Customs Forms on the value of .22 caliber Browning rifles that FN had been making under license and shipping to Browning. The investigation had dragged on inconclusively for five years until the U.S. Army became interested in the Mag-58 contract. At this point, FN decided to cooperate with Federal prosecutors and provide evidence that was crucial in convicting John Val Browning, President of Browning. In the words of one FN official, "we became more and more aware that our interests were not identical with those of Browning." Mr. Browning, grandson of the prestigious arms concern's founder, was indicted in 1976, and shortly afterward resigned the Browning Arms presidency. The following year, the Belgian arms manufacturer had not only won the U.S. Army contract, but bought Browning Arms Co. for $20 million. (Tim Metz, "Browning Arms Got Shot Down and Taken Over," Wall Street Journal, September 28, 1979, p. 18.)

[93]Jeff Melvoin, "Court Blocks Army's Purchase of Machine Guns from Belgium," American Metal Market/Metalworking News, July 12, 1976, p. 7.

[94]Jeff Melvoin, "Maine, Maremont Challenge U.S. Arms Award to Belgians," American Metal Market/Metalworking News, May 24, 1976, p. 4.

[95]Ibid.

[96]Melvoin, "Court Blocks...," op. cit. p. 42.

[97]"Germany Wins a Battle," The Economist, February, 1978, p. 52.

[98]"Army to Adapt West German Gun for Use on Later XM-1 Tanks," Aerospace Daily, February 1, 1978, p. 162.

[99]Aerospace Daily, December 6, 1977.

[100]"Army to Adapt...," op. cit.

[101]Ibid.

[102]The U.S. DoD also provided two other significant offsets linked (at least explicitly by the Germans) to the NATO AWACS project. These involved the purchase of German trucks and telecommunications equipment.

[103]Army to Adapt...," op. cit.

[104]Ibid.

[105]"Epreve pour le gouvernment belge," Le Monde (Selection Hebdomodaire), le 22 fevrier, 1979, p. 1.

[106]"Belgium Plans Buy of Hawk Missile," Aviation Week & Space Technology, February 5, 1979, p. 20.

[107]Ibid.

[108]Ibid.

[109]Interviews with H. Steve Tremper, Vice President, Boeing of Canada Limited, between September and November, 1981.

[110]See Chapter 5, sub-chapters A and D for more detail on this early history of defense procurement within the Alliance.

[111]A large percentage of this domestic procurement involved license production of U.S. equipment for the Canadian Armed Forces, plus equipment provided to the allies paid for by U.S. MAP.

[112]Tremper, op. cit.

[113]Ibid.

[114]The 1973-5 actuals cover January 1 to December 31, the 1976 involve only the first six months, while 1977 and on cover, a period extending from July 1 of the preceding year to June 30 of the same year.

[115]Tremper, op. cit.

[116]The Canadian CH-113 and CH-113A, the Swedish HKP-4's, the Japanese KV-107 and the USN and USMC CH-46's are all national variant's of the V-107 family of helicopters.

[117]The Winnepeg subsidary of Boeing, with employment approaching the 1000 mark in the early 80's, was originally established in the early 70's as a result an agreement linking it to the purchase of six 707's by Canadair.

[118]Arnprior's average employment for the mid-1980 to mid-1981 period was 306 persons with a payroll of $5,445,623. Approximately 50 percent of Boeing of Canada, Arnprior Division, business is acquired from sources in the United States.

[119]Long-Term Canadian Supplier Relationship Program, Boeing Vertol Company, July 1981 (Annual Report).

[120]"British Buying CH-47," Aviation Week & Space Technology, January 30, 1978, p. 34.

[121]"RAF's New Chinooks Will "Fly Marconi", Military Technology, Issue 8, March/April 1979, p. 32.

[122]Interviews with John Mc Lean, Boeing Vertol's Manager for Inventory Management, Traffic, Materiel Control and Division Offset, between September and November, 1981. (Note: After years, the office was combined with several others within Vertol Materiel.)

[123]Ibid.

[124]Ibid.

[125]The original going-in position of the Spanish had been for a 30% guarantee for work placed, not just requests for proposals issued.

[126]The offset agreement is covered in detail in clause sixteen of the contract.

[127]Mclean, op. cit.

[128]The Italian M113 license production program is covered in detail in Chapter 6.

[129]"The Netherlands: A Tank Contest Offers billion-dollar prizes," Business Week, October 2, 1978, pp. 45-6.

[130]"Leopard 2," NATO's Fifteen Nations. April-May 1979, p. 88.

[131]Claus- Detlef Lehmann, "An Industrial View of Armament Export and Collaboration," NATO's Fifteen Nations, October/November, 1978, p. 70.

[132]Ibid.

[133]Canada participated in the drawing up of operational characteristics and specifications, and ultimately the selection of the Breguet 1150 design during 1957 and 1958 as the basis for joint development of a NATO standard Maritime Patrol aircraft, designated the Atlantic. Canada, however, dropped out of the NATO program at the end of 1958 to continue unilaterally with its own system, the Argus, to fill its requirement.

[134]The Canadian Forces' Greenwood base in Nova Scotia will be the main point of operations for the Aurora fleet, with 14 of Canada's 18 Auroras based there. The main operations center, maintenance and aircrew training, and the data interpretation and analysis center will be located at this facility. The remaining four aircraft will be based at the Comox base in British Columbia. (Jeffrey M. Lenorovitz, "Aurora for Canada Rolls Out on Time," Aviation Week & Space Technology, January 22, 1979, p. 20.)

[135] Boeing has recently been more successful elsewhere in making in-roads into the Lockheed monopoly in the area of maritime patrol aircraft. In mid-1980 Boeing captured the Royal New Zealand Air Force contract worth $21 million for the modernizing of its 5 aircraft force of Lockheed P-3B Orions. Be it on a much more limited basis, the contract could be of considerable long-term significance as other nations opt for modernization as opposed to replacing their existing systems.

[136]In comparison, since the Dutch P-3C's (covered in Chapter 5 as part of the Breguet Atlantic project history) were purchased through FMS, the offset is covered in a letter of agreement between the Dutch government and Lockheed.

[137]Barry Miller, "Canadian CP-140 Offset Sets Precedent," Aviation Week & Space Technology, June 6, 1977, p. 149.

[138]Ibid.

[139]Ibid.

[140]Ibid., p.153.

[141]Ibid.

[142]Ibid., p. 152.

[143]Jeffrey M. Lenorovitz, "Aurora for Canada Rolls Out on Time," Aviation Week & Space Technology, January 22, 1979, p. 20.

[144]Miller, op. cit., p. 147.

[145]Ibid., pp 147-148.

[146]Ibid., p. 148.

[147]Lenorovitz, op. cit., p. 20.

[148]Miller, op. cit., p. 153.

[149]"CAE Simulator for Dutch P-3C," NATO's Fifteen Nations, April/May 1982.

[150]Ibid.

[151]"A Fighter Contract Tied to Jobs," Business Week, September 12, 1977, p. 42.

[152]"Canada Being Offered Mix of Grumman F-14, GD F-16 Fighters," Aerospace Daily, May 31, 1978, p. 165.

[153]"Defense minister outlines seven-point offset policy," Aerospace Canada, summer 1978, p. 16.

[154]A mix of Grumman F-14s and General Dynamics F-16s had been proposed to Canada the previous May. A package combining F-14s and F-16s would have helped Canada meet its requirements for air defense of a large continent and its responsibilities to NATO to provide air to ground capability.

[155]In the final days before the announcement of the short list, the Canadian press had reported that the Department of Industrial Trade & Commerce preferred the F-18L because of a reportedly more generous Northrop package enabling Canada to tap markets for aerospace and non-aerospace products.

[156]"Danson Statement on Canadian Fighter Competition," Aerospace Daily, November 30, 1978, pp. 130-2.

[157]The offers of 142 F-16 aircraft and 127 F-18A aircraft were based on the assumption that waivers would be granted by the U.S. exempting the sales from research and development recovery costs. Such exemptions can be granted only in the interest of NATO standardization. The Canadian government pressed that argument, as well as the contention that a better prepared Canadian air defense would relieve the strain on U.S. Air Force responsibilities. (Alton K. March, "Canadian Fighter Race Stiffens," Aviation Week & Space Technology, December 4, 1978, p. 16.)

[158]"Fighter Competitors' Offsets Detailed," Aviation Week & Space Technology, December 4, 1978, p. 16.

[159]Ibid.

[160]"Canada Being Offered Mix of Grumman F-14, GD F-16 Fighters," Aerospace Daily, May 31, 1978, p. 166.

[161]John Urquhart, "New Twist is Seen Probable in Contest to Provide Canada with Fighter Planes," Wall Street Journal, May 31, 1979, p. 12.

[162]"General Dynamics Lines Up Team for Canadian Fighter Program," Aerospace Daily, October 17, 1979, p. 226.

[163]Erwin J. Bulban, "Canadian Fighter Spurs Offset Battle," Aviation Week & Space Technology, November 26, 1979, p. 35.

[164]Ibid.

[165]Ibid.
[166]Ibid.
[167]Ibid., 36.
[168]Bulban, op. cit.
[169]Ibid.
[170]Ibid.
[172]Morgan, op. cit.
[173]Ibid.
[174]Ibid.
[175]Ibid.
[176]Ibid.
[177]Ibid.
[178]"General Dynamics Lines Up Team ....," op cit.
[179]Ibid, pp. 226-227.
[180]"McDonnell Douglas is Sued by Northrop, its F18A Partner,on Sale Bid to Canada," Wall Street Journal, October 30, 1979, p. 17.
[181]Ibid.
[182]Ibid.
[183]"Canadian F-18 work agreed," Flight International, 15 December, 1979, p. 1988.
[184]"McDonnell Accedes to Northrop on Canadian F-18 Dispue," Defense/Space Daily, December 6, 1979, page 162.
[185]"McDonnell Douglas Files F-18 Counterclaims Agaisnt Northrop," Aerospace Daily, January 4, 1980, page 19.
[186]Ibid.
[187]Ibid.
[188]Ibid.
[189]"U.S. Objects to Portion of McDonnell Douglas Offset Proposal to Canada," Aerospace Daily, November 20, 1979, page 102.
[190]"Offset Controversy" Aviation Week & Space Technology, November 26, 1979, page 34.
[191]"Canadian Fighter", Aviation Week & Space Technology, April 7, 1980, page 13.
[192]"Canada, Hornet Picked as NFA", Defense & Foreign Affairs Daily, April 16, 1980.
[193]Ibid., Also weighing in the Canadian decision were persistant press reports, discounted by some defense analysts, concerning the alleged shortcomings of the Pratt & Whitney F-100 engine in the F-16.
[194]Ibid.
[195]"Canadian CF-18", Interavia Air Letter, April 23, 1980, page 2.
[196]"Canada Expects U.S. Proposal Soon on Waiver of F-18 R&D Costs," Aerospace Daily, July 10, 1980, page 49.

[197]Ibid.

[198] Ibid.

[199] Ibid.

[200] Ibid., page 50.

[201]"Brown, Lamontagne Conclude CF-18 Negotiations", Aerospace Daily, December 18, 1980, page 239.

[202]Ibid.

[203]"Lehman Memo on Non-Recurring F/A-18 Cost", Aerospace Daily, January 26, 1982, p. 125.

[204]"Industrial Off-Set Figures for CF-18 Released," Aerospace Daily, March 5, 1981, p. 29.

[205]Back in 1978 Deputy Secretary of Defense Charles W. Duncan Jr., had issued a memorandum that removed the Pentagon from any responsibility for regulating offset agreements.

[206]Michael R. Gordon, "Pentagon, Contractors Divided Over Foreign Arms Co-Production Deals," National Journal, 2/20/82, p. 331.

[207]Ibid.

[208]To say nothing of the markedly deteriorating state of France and Spain's relations since the late 70's over agricultural policies and Spanish entry to the E.E.C.

[209]Espagne: Plutot que des Mirage 2000, Le Government Decide D'Acheter 84 Chasseurs Americains F-18," Le Monde, 26 juillet, 1982, p.3.

[210]"Spain Delays Proceedings in F-18 Purchase," Aviation Week & Space Technology, August 30, 1982, p.22.

[211]Morgan, op. cit.

[212]Ibid.

[213]Ibid.

[214]Ibid.

[215]Ibid

[216]Ibid.

[217]"Athenes veut acheter a la France des avions Mirage-2000 et des missiles anti-aeriens," Le Monde (hebdomadaire), April 22-28, 1982, p.5.

[218]Aerospace Daily, "Greece Steps Up Search for New Fighter," March 5, 1982, p. 35.

[219]"Panavia Offers Greeks Offsets on Tornado," Aviation Week & Space Technology, May 10, 982, p. 20.

[220]The Greek Socialists have also reopened the low altitude air defense missile competition after a Swiss-American Contravez-Raytheon hybrid system had been selected the previous year over the French Crotale, Franco-German Roland, and Raytheon's Landsparrow derivative of the NATO Seasparrow system.

[221]"Panavia Offers...," op. cit.

[222]Ibid.

[223]Ibid.

[224]Ibid.
[225]Ibid.
[226]Athenes veut acheter . . .," op. cit.
[227]Ibid.
[228]Ibid.
[229]"Panavia Proposes Greek Fighter Offsets," Aviation Week & Space Technology, October 11, 1982 p. 22.
[230]Ibid.
[231]Ibid.
[232]Ibid.
[233]"La France a la recherche d'un systeme de detection aeroporte: L'E-2C Hawkeye de Grumman est une solution possible; il y en a d'antres, "Air et Cosmos, 28 November, 1981, p.33.
[234]Ibid.
[235]Ibid.
[236]"Boeing Offers CFM-56-Equipped AWACS to France," Aerospace Daily, August 2, 1982, p. 171.
[237]Ibid.
[238]Ibid.
[239]Ibid.

Chapter 12

MODE #7 - TRANSATLANTIC JOINT PRODUCTION AND/OR SYSTEMS INTEGRATION BY A U.S. LED INDUSTRIAL TEAM (i.e., INVOLVING NO JOINT DEVELOPMENT)

I. INTRODUCTION

For comparative purposes this Mode of industrial collaboration can be viewed from 2 vantage points. In one sense it is an expansion of Mode #6, in being multi-lateral instead of bi-lateral in nature. In another sense it is a contraction of Mode #5 of industrial collaboration in that Mode #5 included U.S. led transatlantic joint production efforts, though significant joint development as well. These U.S. led joint production and/or systems integration industrial teams included in Mode #7 involve little or no joint development, and are for systems being purchased by government consortia following an international competition. In all these cases except the HELIP project, the U.S. government was a participant in the purchasing consortia. This Mode first appeared in 1958 within the framework of the NATO Infrastructure Program and expanded to weapon systems in the mid-70's with the HELIP, the F-16, and later the NATO AWACS projects. Virtually all projects in this Mode have been linked to some extent to some sort of external offset, as well.

In each case, both the NATO Infrastructure Program projects and the three weapon system projects, the U.S. lead industrial team was selected following a competition. In the case of the three weapon system projects, reaching concensus on source selection was possible because no feasible alternative to the U.S. system was available within the selecting European nations.

1. C^3 and Early Warning/Air Defense Projects funded through the NATO Infrastructure Program

With the NATO Infrastructure Program, as with all other areas of collaboration in defense procurement there is the concern for 'juste retour', one involving a balancing of military requirements and economic benefits for something that is a 'public good'. Besides this though, for the NATO Infrastructure Program there has also been the consideration of ability to pay, one that is no longer a consideration in the area of weapon systems except for the three developing nations of the Alliance: Greece, Portugal, and Turkey. For NATO Infrastructure these concerns can generally be offset through the advantages concommitant with the geographic distribution factor relevant to brick and mortar projects (e.g., local architectural and construction firms), being further balanced by the international competitive bidding (ICB) procedures for NATO Infractructure projects (NATO Document D/2611). But for the 1/3 of the contracts where high technology is involved, and especially the larger projects at that, the need to offset another unquantifiable factor, technology, is introduced. Therefore with the larger high technology projects represented by the NATO Air Defense Ground Environment (NADGE), the component projects of the NATO Integrated Communications system (NICS) such as the SATCOM ground and space segments, the need to offset technology often requires project specific internal offsets, as well as some external offsets.

The NADGE program required work sharing amounting to 98% of each nation's contribution, and therefore offset almost totally on an internal basis, each nation's financial contribution. Whereas the NICS is a multi-project program involving well over a billion dollars in contracts, in which globally the U.S.

is guaranteed a 38% share of the business, another 20% is up for grabs and the remaining 42% is guaranteed to the other nations in proportion to their contributions. For one of the NICS projects, the $80 million SATCOM III ground segment contract in June 1978, Ford Aerospace was required to lay off 37% of the work to the industries of the three largest contributing nations after the U.S.: the FRG, Italy, and the U.K.

2. Weapon Systems

The HELIP program involved a major up-grading through modification of a U.S. system, the Hawk surface-to-air missile, previously produced in Europe under license. This was basically a result of the customer governments having approached the project with greater cost consciousness (and previous experiences with a multi-national production consortium) combined with the FRG's decision to use its share in the program to offset U.S. troop costs. The F-16 consortium involved the replacement aircraft for the F-104 by a group of smaller European nations that had previously opted out of a joint development effort, the MRCA Tornado, while not being interested simply in assembly of a foreign system under license, i.e., the quantity ordered could not justify full scale license production in Europe (only assembly with limited manufacturing of components).

A distinguishing characteristic of this Mode from Mode #6, one that is part and parcel of the expansion to a multi-lateral basis, is that the customer became much more complex, with the buying nations assuming an active role in project management. Either a NATO Production and Logistics Organization

(NPLO) was set up, or a Steering Committee was, with the latter accompanied by multi-national staffing of a U.S. SPO. In this sense it is not just another sale to a foreign government with industrial offsets being passed to the government's industry (Mode #6), but an actual project, one in which project management and the whole contracting process is impacted by the increased leverage and participant status of the customer governments. This difference is also reflected in the way the lead U.S. firm manages the integrated subcontract management effort (and in this sense it is similar to Mode #5 projects, NATO Sea Sparrow in particular). Another factor further complicating the effort is the inevitable fluidity of the set of governmental/industrial participants, along with the linkage (at least on the European end) to some sort of U.S. government provided external offset.

There is a case for treating the NATO AWACS project as a parallel off-shoot of the quasi-alliance-wide NATO infrastructure program (the author's original approach), since the previous generation Early Warning/Command and Control systems were funded through this program (and it was briefly considered early-on for NATO AWACS). However, the NATO AWACS project is placed here in Chapter 12 with the other two weapon system projects, not in Chapter 3 with the other C^3/I projects funded through the NATO Infrastructure Program and falling into this Mode of industrial collaboration. The facts are that: the NATO AWACS/ Command and Control system does not primarily involve fixed facilities, but an airborne platform; for a number of reasons the NATO Infrastructure Program's co-funding formula could not be applied; and one of the key funding nations among the 13 regular NATO Infrastructure Program participants dropped out two years into the final stage of planning for the program.

A. HELIP (THE EUROPEAN IMPROVED HAWK PROGRAM)

In January, 1974, Raytheon received the prime contract from the Paris based NATO Hawk Production and Logistics Organization (NHPLO)[1], to lead an international industrial consortium for the $750 million Hawk European Limited Improvement Program (HELIP). HELIP was the independent European equivalent of the U.S. Improved Hawk program. The name, Hawk European Limited Improvement Program, is a relic of the original goal of incorporating European technology into what was to be an independent European improvement program. This, however, as we will see shortly, never worked out.

Raytheon's share of the work as prime contractor, was $400 million, with firms from Italy, Netherlands, France, and the FRG obtaining some $260 million in contracts. The NHPLO Placed another $90 million contract with Hazeltine Corp. for AN/TPX-46 IFF equipment to tie the European systems in with those of the U.S. stations in Europe, a contract with Applied Devices Corp. for conversion kits to update the AN/TPQ-21 simulator to an improved AN/TPQ-29 simulator, and the U.S. government received contracts for GFE and quality assurance services on work performed in the U.S.[2]

1. The U.S. Army's Improved Hawk Surface-to-Air Missile System

The history of HELIP goes back some 10 years from this contract award (i.e., ignoring the NATO Hawk program dating from 1958), to 1964, when R&D was initiated for an Improved Hawk program--the U.S. Army having decided that the Basic Hawk was to be upgraded so as to prolong its effectiveness. The Improved Hawk configuration was defined in 1966, and in 1969 the industrial prototype was



Improved Hawk Missile Source: Raytheon

completed. The new system involved improvements in electronic-counter measures (ECM), reaction time, lethality and its ability to cope with the higher speed and greater maneuvering capabilities of newer aircraft. This involved a totally new missile, and modifications to the Ground Support Equipment plus the incorporation of a new item, the information and coordination central. By December 1971, after extensive testing, the system was ready for production. In August 1972, the system was ready for deployment, with Initial Operational Capability occuring three months later.[3]

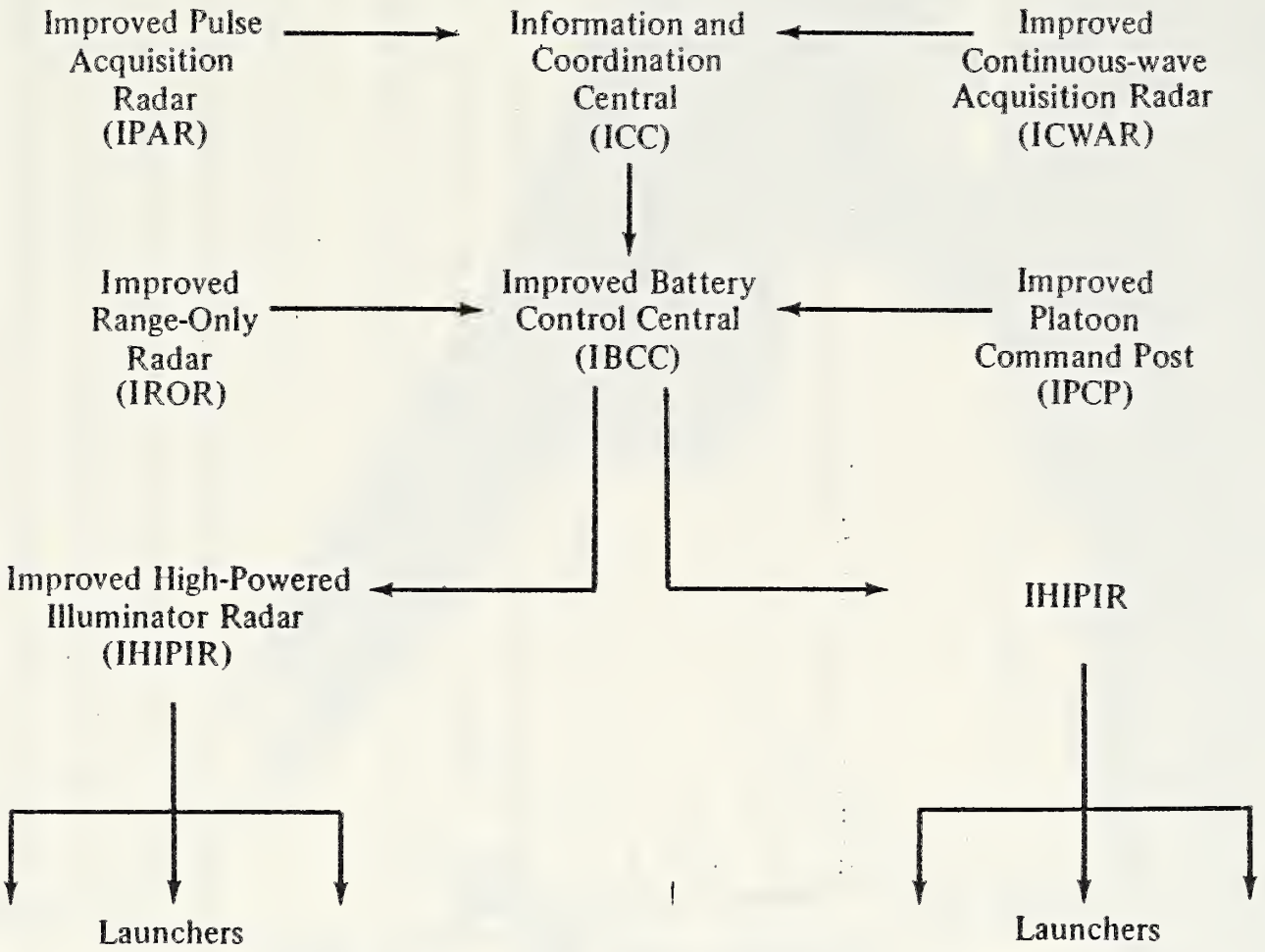
The Improved Hawk missile system detects, identifies, tracks and destroys airborne targets. The Improved Hawk missile uses a semi-active homing type of guidance system in which the RF transmitter is ground based and the receiver is in the missile. The missile has a range in excess of 35 km. and can reach altitudes of greater than 15 km.

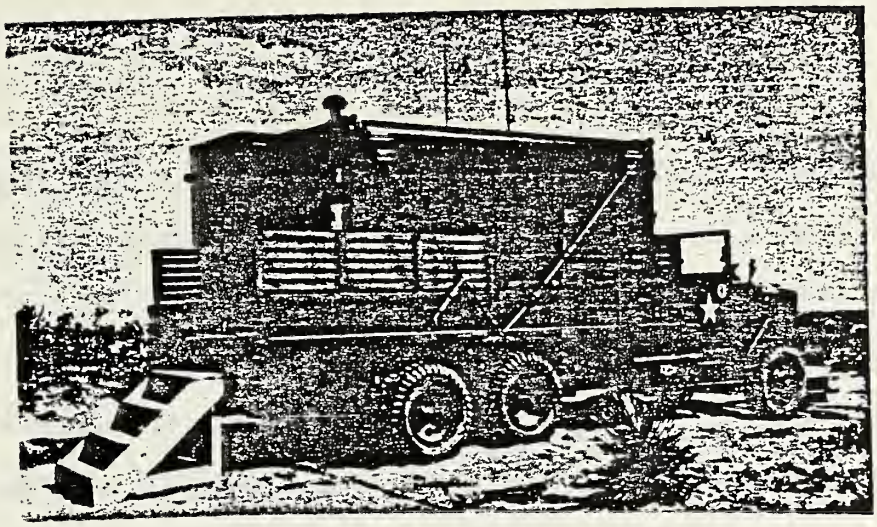
A U.S. Army Improved Hawk Battalion is organized with a headquarters and one headquarters battery, plus four firing batteries. A battery consists of the following Ground Support Equipment:

- The improved continuous-wave acquisition radar (ICWAR) which provides low-to-medium altitude target detection, while the improved pulse acquisition radar (IPAR) is used to provide medium to high altitude detection coverage.

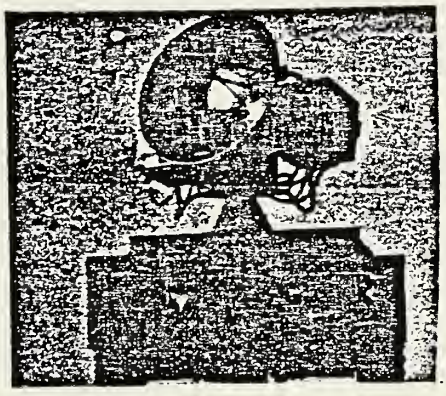
- The information and coordination central (ICC) functions as the battery fire control data processing and operational communications center. The

Improved Hawk Battery

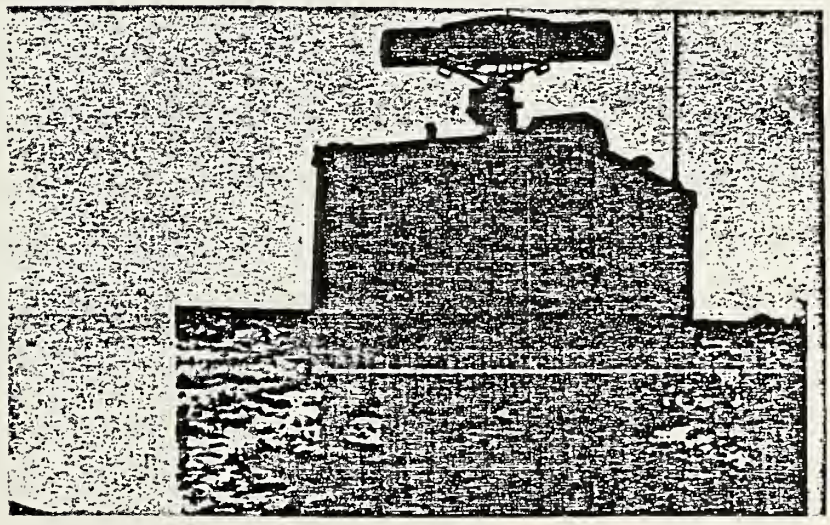




Improved battery control central.



Improved range-only radar.



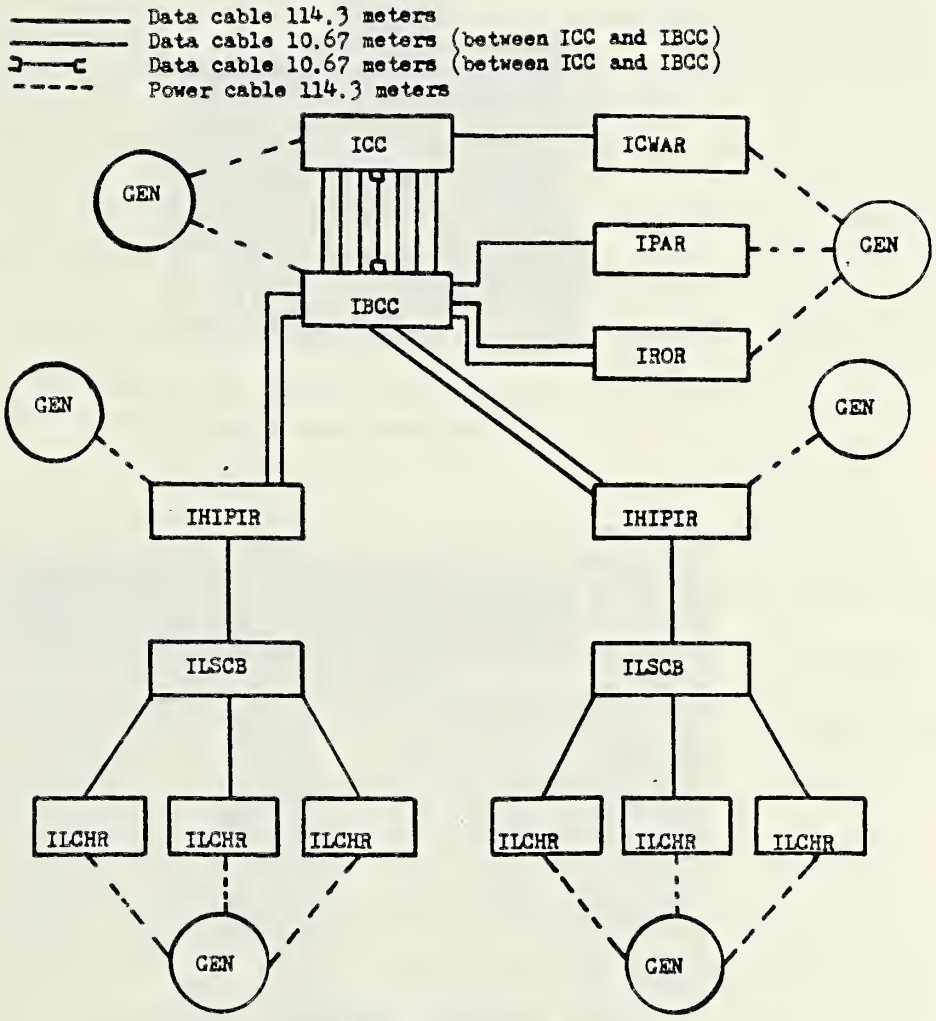
Information coordination central.

ICC contains: an automatic data processor (ADP) for input from the battery radars; a Mark XII AN/TPX-46 identification, friend or foe (IFF) system; and communication equipment.

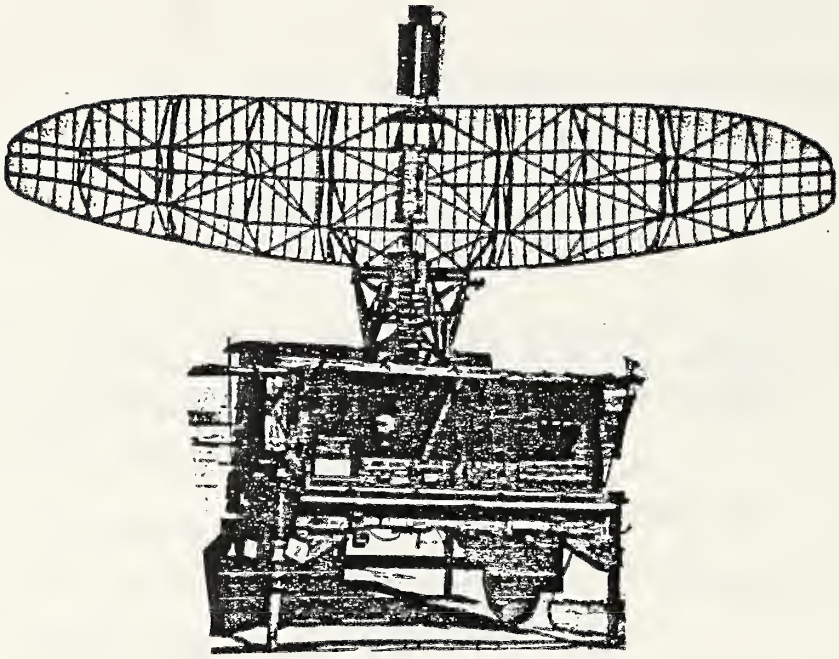
- The improved battery control center (IBCC) is the fire control center for the Improved Hawk battery. It contains the equipment required for remote control and operation of the radars, and for missile firing. It is operated by a crew of four and a tactical control officer (TCO). The IBCC has displays and indicators that are used during an engagement to detect, identify, evaluate, assign, and fire upon targets.

- The improved platoon command post (IPCP) is used to monitor and control firing operations of a battery's improved assault fire unit (IAFU). The IPCP houses a tactical display and engagement control console (TDECC), an IFF interrogator set, tactical communications equipment, an AN/GSA-77, and a modified ADP.

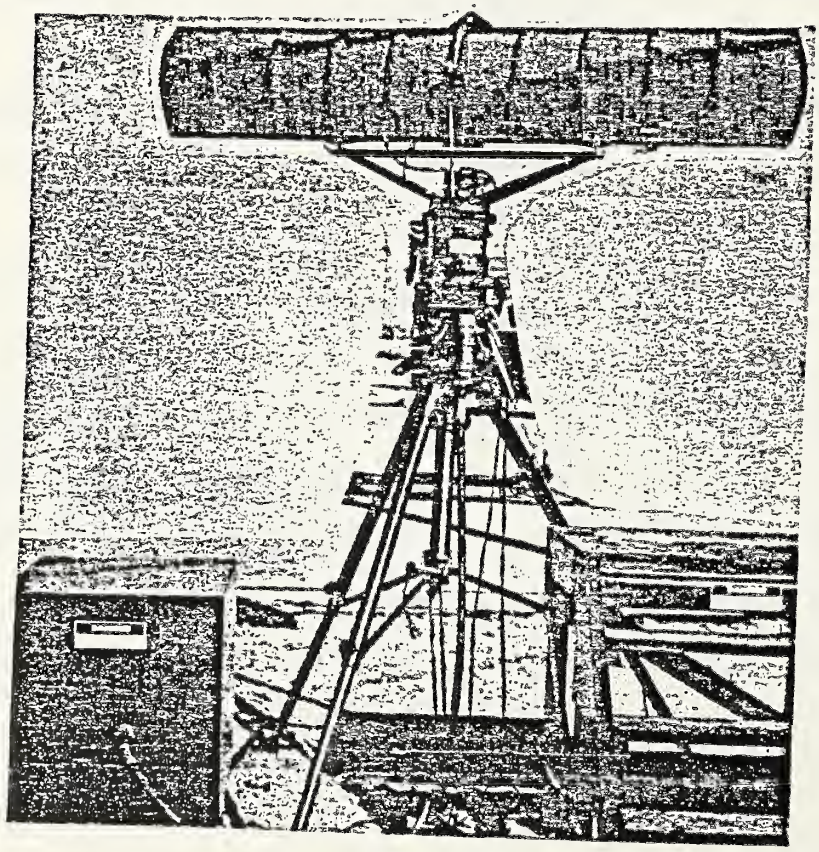
- The improved high-powered illuminator radar (IHIPIR) is the tracking radar of the battery. A continuous-wave radar, it uses the doppler principle to lock on and track assigned targets. Each battery has two IHIPIR's, which operate independently of each other to allow two targets to be tracked and engaged simultaneously. Each IHIPIR is connected by cable to the IBCC and, through a launching section control box, to three launchers in the firing section. During an engagement the IHIPIR supplies target data to the IBCC, ICC, launcher, and missile.



Improved Hawk mobile battery cable layout.



. Improved pulse acquisition radar.



IFF antenna.

- The improved range-only radar (IROR) is a pulse-type radar that provides target video to the IBCC to allow an operator to set range for a jammed IHIPIR when necessary.

- The improved launcher (ILCHR) has three basic purposes: to aim the missiles, to send prelaunch commands to the missile, and to send data to the IBCC. During an engagement, after fire, the launcher activates, slaves to, and tracks with the IHIPIR, accepts lead angle positioning information from the IHIPIR to aim the missile at a predicted kill point, and launches the missile. The launcher may be positioned throughout 6,400 mils in azimuth and may be raised and lowered in elevation.

Other elements of the system include the electric power generators (6 per battery), the improved launching section control box (which distributes signals between the IHIPIR, IBCC and ICC), the loader transporter (3 per battery), and off course the missile itself (3 per launcher, with 3 launchers per battery).

2. The NATO-Europe Program Is Launched

As for the European response to the U.S. Improvement Program, the five participating governments (PG's) of the NATO Hawk Program (France, the FRG, Netherlands, Belgium, and Italy, jointly producing the USA/Raytheon (Basic) Hawk under license) started the exploratory phase for a new follow-up program in

November, 1967. The Improved Hawk's receiving the designation of HELIP in Europe was a result of the initial concept being one of enhancing program

Improved Hawk: ready to defend NATO airspace.

Improved Hawk stands ready in Europe: ready to defend NATO airspace against today's faster and more maneuverable threats. It is also a prime example of international cooperation and weapons standardization.

With Raytheon as systems contractor, production of Improved Hawk is nearing completion for seven European NATO nations—an effort that involved firms in four countries. And, under a recent agreement, a NATO consortium will soon undertake the manufacture and installation of the latest Product Improvement Programs (PIPs) for the system.

These improvements, which use the latest technology to expand the system's capabilities, were developed and produced by Raytheon for the U.S. Army and Marine Corps.

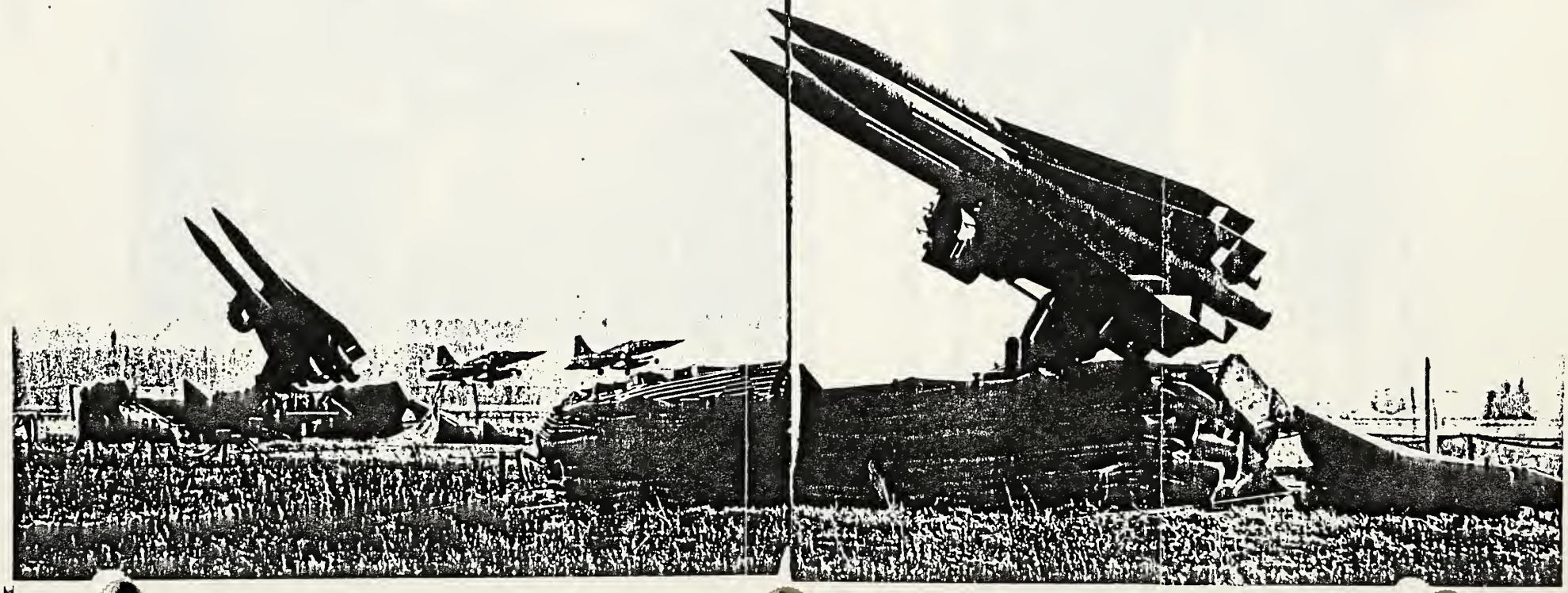
The result of this international teamwork is a NATO standardized air defense system that is capable of meeting increasingly sophisticated threats. It is a system that features advanced solid-state electronics, digital technology, and fast reaction time.

Improved Hawk can defend against aircraft flying at all tactical altitudes, from the maximum down to treetop levels. The missile itself is a maintenance-free unit that requires no field or on-site testing by the user.

Improved Hawk—ready in Europe and in other nations throughout the free world. For a brochure on Improved Hawk, write on your letterhead to Raytheon Company, Government Marketing, 141 Spring Street, Lexington, Massachusetts 02173.

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support among the 5 PG's by finding ways for their contributing to the R&D effort for the new program. Although this never occurred--the attempt to introduce into the Improved Hawk a European developed low altitude acquisition system was eventually dropped--the name of HELIP remained, even though HELIP System and the U.S. Improved Hawk were to have identical configurations (though the European configuration lagged behind over time).

Actually, suggestions for improvement of the NATO Hawk were proferred by several of the program's five National Prime Contractors (NPC's),[4] and their subcontractors as early as 1963. Yet, due to preoccupation at this time with production problems, a very thin technical staff, and an unwillingness to use the program's French (i.e., Thomson-Houston) dominated Technical Documentation Center for development work, such improvement proposals received little support from the European Prime Contractor, Societe Europeene de Teleguidage (SETEL).— With some of Europe's best engineers working on the system the pressure built up, however, and in the summer of 1964, SETEL submitted to the NHPLO's Management Office (NHMO) a proposal for a development program aimed at a major improvement in performance. The low-key effort reflected only a collection of individual proposals from the NPC's, not an integrated systems proposal, and the matter was again dropped.[5]

When the matter came up again in 1966 for improvement of the NATO Hawk System, it was the NHMO that initiated a new study to determine what U.S. improvements might be incorporated into the NATO Hawk. The result of the study was a recommendation by the NHMO to the BOD of the NHPLO, that a Hawk European Limited Improvement Program (HELIP) be inaugurated for the system.[6]

Beginning in 1967, the NHPLO conducted tests over a 2-year period involving five configurations from four European countries. During the second year of testing the U.S. configuration was included, being ultimately the one chosen. On this point Raytheon's Hawk Program Manager, Eric Levi, felt that the decision was not only influenced by technical, but also, to some degree, by Standardization considerations of reducing logistics support costs. During this initial phase, which came to an end in 1970, European Industry had been collecting technical, operational, industrial and financial data on the program. During the same period HELIP suffered considerable delays stemming from the difficulty of aligning the national military requirements, as well as the usual economic and industrial considerations of the PG's.[7]

Meanwhile, the U.S. government and the NHPLO had reached an agreement in 1968 that if the Improved Hawk was produced for NATO (meaning in this case some combination among the seven European PG's - the original five, plus the two U.S. grant aid recipients, Greece and Denmark), the U.S. would grant the production rights, as it did previously with the Basic Hawk. However, unlike the previous program, the U.S. government this time required the payment of a portion of the nonrecurring R&D costs. Due to the U.S. program's still being in the R&D stage, the licensing agreement covered R&D Technical Data Package (TDP) and associated know-how immedi-ately, with provisos for the prototype production TDP and know-how as a follow-on, and the production TDP and know-how in the case of a production decision being made.[8]

In addition, the Raytheon license would not be with the European industrial consortium's SETEL, as previously. Instead it would be with the NATO subsidiary agency, the NHPLO, which, unlike its industrial counter-part, was to survive the initial program. The contractual authority of the NHPLO (which had been blocked by France during the 1958-60 negotiations for the NATO Hawk Program) had since been recognized.

3. The Selection of a Prime Contractor

a. The First Request for Proposals

In 1970, SETEL, which had previously been designated to submit a program plan proposal on a sole source basis, had its proposal rejected. Levi felt that this stemmed partially from considerations of cost, and partially from a more general disenchantment with utilizing a consortium-type European Prime Contractor, as with the earlier NATO Hawk program. He felt that the reason the NHPLO did not repeat the approach followed during NATO Hawk at the industrial level, was due to SETEL's having created the image of it not being the master of its own fate, but more of a servant of the 5 National Prime Contractors (NPC's).[9]

As an outgrowth of the NATO Hawk experience, this time around the government consortium, the NHPLO, reached agreement that there would be a prime contractor consisting of a single firm fully responsible for all aspects of the program, instead of creating an inter-firm company specifically for the project.

Moreover, whereas the contract for the NATO (Basic) Hawk had been a cost reimbursement type contract, greater emphasis on cost/effectiveness than in the

previous program (which had been heavily weighted toward maximizing technology transfer to all five NPC's), led to the use of a firm fixed price contract for HELIP.

Consequently, in 1971 the NHPLO made a request for competitive program plan proposals from the individual European firms which, naturally enough, were to be the original NPC's, those of the three national governments having chosen to participate by this time, the FRG, Italy, and the Netherlands .

b. The Second Request for Proposals

Subsequent to this, the three NPC's of the previous program that were to represent the participating countries at the industrial level—AEG-Telefunken, Philips, and Selenia— decided not to procede individually but to form a new consortium with AEG-Telefunken acting as prime contractor. Simultaneously the NHPLO borrowed an Improved Hawk industrial prototype battery from the U.S. government in order to conduct independent testing and convince the governments of the advantages of adopting an Improved Hawk/HELIP system. Immediately thereafter, as the AEG-Telefunken led team was the only bidder, the NHPLO asked Raytheon to submit a competitive proposal. Levi felt, at the time, that the Raytheon and AEG-Telefunken proposals were not really comparable, because the Raytheon proposal, submitted in 1972, was restricted to the production of hardware only, on the already existing U.S. production line, whereas the AEG-Telefunken proposal included the setting up of a new production program. Also in 1972, one of the MAP recipients of the U.S. share of NATO Hawk production, Greece, joined the NHPLO and decided to participate in HELIP, bring-ing the number of participating nations up to four.[10]

NATO HAWK PROJECTS

	Years	Value	Prime Contracors for NATO - Europe Programs	Procuring Authority	Participating Nations
NATO Hawk (Basic)	1958-67	$670M	Paris based Societe Europeenne de Teleguidage, SETEL, co-owned by five national prime contractors: ACEC (Belgium); AEG (FRG); Philips (Netherlands); Selenia (Italy); and Thomson (France)	Five National Governments and the NHPLO[1]	Belgium, France FRG, Italy, Netherlands, (& U.S.[2])
Hawk European Limited Improvement Program (HELIP)	1967-80	$750M	Raytheon's Paris based subsidiary RAYTAS, subcontracting 40% of work package to Italian, Dutch, French and German firms	NHPLO[3]	Denmark, France FRG, Greece, Italy, and Netherlands[4]
Hawk European Product Improvement Program (PIP)	1980-84	$150M	GRIP (a Groupement d'Interet Economique, co-owned by MBB and Thomson) subcontracting to firms of all seven participating nations	NHPLO	Belgium, Denmark, France, FRG, Greece, Italy and Netherlands

[1]The NATO Hawk Production and Logistics Organization (NHPLO) is located at Reuil Malmaison near Paris. It was the NATO Production and Logistics Organization (NPLO) managing the NATO Hawk Project for all five European governments procuring the Hawk system. However, for Basic Hawk, each government contracted on its own directly with the industrial consortium, SETEL. For HELIP and PIP, the NHPLO both contracted for, and managed the programs for all participating governments.

The NATO Maintenance and Supply Organization (NAMSO) located in Luxembourg, entered the picture gradually between 1965 and 1975 as the NPLO responsible for the support of deployed Hawk systems (e.g. calibration, maintenance, and spares support).

[2]The U.S. also participated in NHPLO as the government owning the Technical Data Package being transfered to the NATO - Europe consortium, i.e., as a non-voting member except in the areas of security and configuration control, where the U.S. maintained the right of veto. The U.S. was also a procuring government (through MAP) for those Hawk systems built by SETEL for deployment by two additional NATO member states, Denmark and Greece.

[3]Greece and Denmark later joined the NHPLO and participated directly on their own behalf in the procurement of the Improved Hawk (HELIP) and European Product Improvement Program (PIP).

[4]Belgium did not join HELIP until 1979 as the project was winding down, entering under special arrangements that include several bi-lateral offset arrangements, which amounted to a guarantee of 100% flow-back of expenditures totaling approximately $100M. (See Chapter 11.)

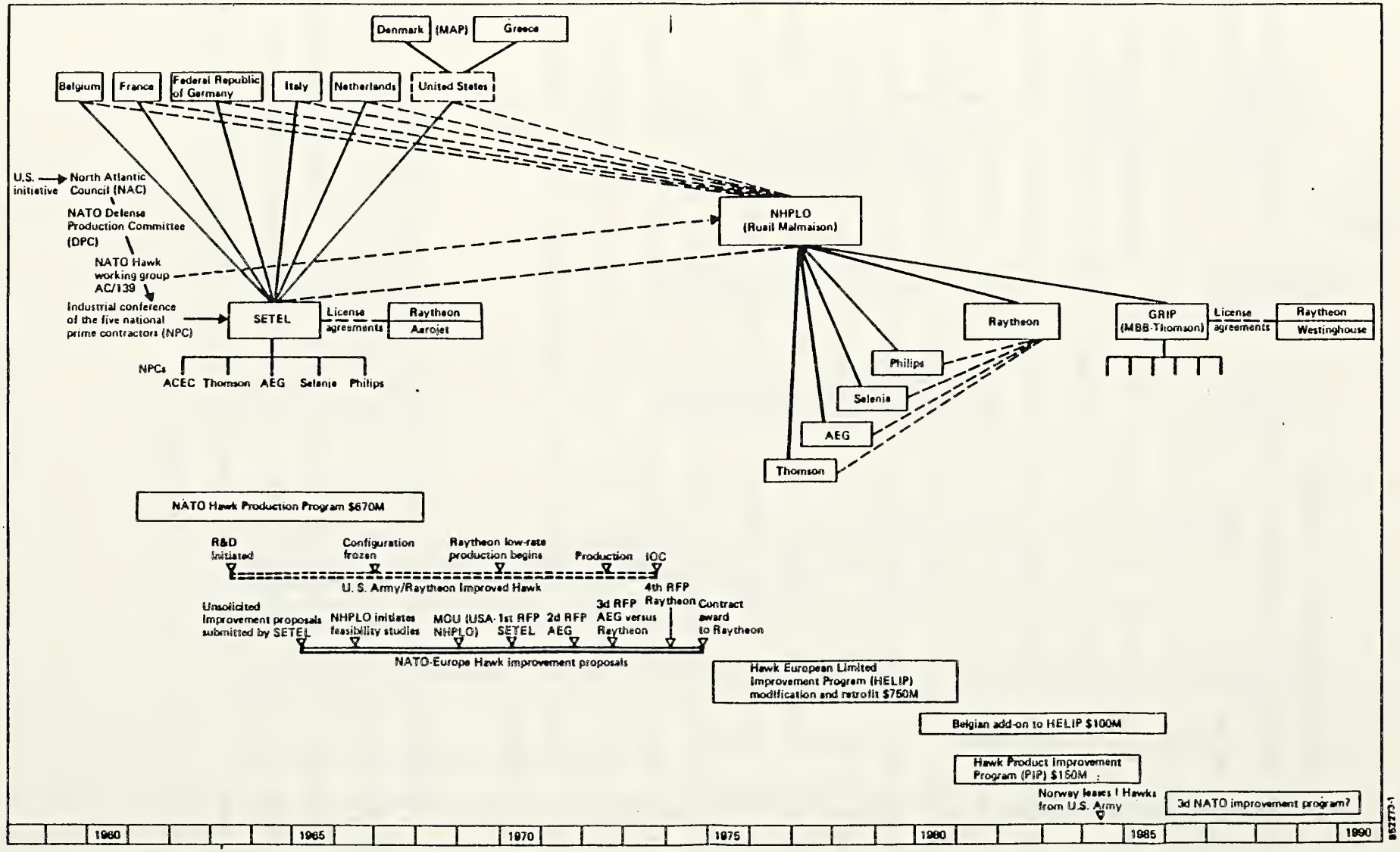
c. The Third Request for Proposals

With the difference of scope mentioned above in mind, the NHPLO decided to request another round of bidding, based on a common scope. Raytheon and the AEG-Telefunken headed team resubmitted their proposals in February 1973, this time both bidding on the total scope of the work. The Raytheon proposal involved all production still being performed in the U.S., with the participation of European firms limited to the overhauling of NATO Hawk Ground Support Equipment. Naturally, these proposals could not be competitive on a strictly cost basis, with a U.S. production line already in existence. Additionally, Levi was still not all that certain of Raytheon's status as a serious contender.[11] Not only on a purely cost basis was U.S. production cheaper, but 2 days after Raytheon submitted its proposal, the U.S. dollar was effectively devalued (with the final collapse of the Smithsonian patch-up of the Bretton Woods international monetary system). To further alter the scenario, the FRG, with its 50% of total program participation at that time, decided that its portion was to be considered as part of the U.S.-FRG offset agreement for U.S. troops stationed in the FRG—which is to say, some 50% of HELIP work would now have to be done in the U.S.[12]

d. The Fourth Request for Proposals (and A Last Minute Revision)

With this drastic altering of the ground rules, AEG-Telefunken dropped out of the program, while Raytheon was asked in June, 1973, to submit a new proposal. So the fourth round began. Raytheon's third proposal was submitted in September of the same year. The new ground rules and guide-lines for this proposal involved the following points:

NATO Hawk Production and Improvement Programs



- 50% U.S. production, and competitive solicitation for subcontracts from all the European participating nations, with Italy being particularly adamant in demanding industrial participation equal to its share of the cost;

- the prime contractor was to have maximum responsibility;

- the price was to be the lowest possible, with the U.S. product price as the goal (working from an FMS price quote);

- it was to be a firm fixed price contract without escalation for the production portion, and the contract would not contain provisions for exchange rate changes.[13]

In November, two months after the submission of the third Raytheon proposal, France reversed its previous position and decided to join HELIP, if certain BOP and technical needs were met. France formally entered the program in January, 1974, and brought the number of national participants up to five. As a result, Raytheon had to submit a revised proposal, so as to include at least minor French industrial participation.

With Raytheon being the sole bidder in the final round, as emphasized by Levi, there was between Raytheon and the NHPLO, "a price negotiation, and a very difficult one" at that.[14]

4. The NATO-Raytheon Prime Contract

Raytheon was awarded the preliminary contract in January, 1974, receiving the final contract several months later, in May. When the NHPLO reached agreement with Raytheon officials, it was on the last day before a several percent rate increase was scheduled to be put into effect by Raytheon and the other Hawk contractors.[15]

Immediately subsequent to the launching of the program, Denmark (the other U.S. MAP recipient of NATO Hawk) joined as the sixth participant. Belgium retained an option to join before February 1, 1974, but did not exercise it, thus being the only NATO nation with the older Hawk system not to replace it with the Improved Hawk. Negotiations over its participation dragged on internationally as well as continuing to be a major political issue domestically until its resolution in January, 1979.[16] NATO faced, in the 5-year interim, the prospect of a 60 km gap in the German - Dutch - Belgium - U.S. Hawk belt stretching across the FRG from North to South.[17]

Greater cost consciousness in the case of HELIP, as compared to the prior NATO (Basic) Hawk program, was primarily the result of:

- the U.S.-FRG offset agreement's shifting the majority of the work outside the procuring nations;

- the general evolution of defense contracting concepts between the late 50's and the mid-70's;

- the different priorities of the two periods, the technology transfer involved in the original missile system program no longer being the paramount concern. This time it was cost and schedule.

Due to these reasons not only was the U.S. contractor selected as the prime, but, instead of sole reliance on cost reimbursement, a mix of four contract types were used:

- firm fixed price (FFP) for production;

- firm fixed price escalatable for overhaul and conversion;

- firm fixed price rate for the technical assistance, and certain manpower related portions, and;

- cost reimbursable for certain overhaul related materials.[18]

The firm fixed price contract for production without escalation provisions was unusual in the European environment, where typically, contracts over 2 years duration have labor escalation clauses.[19]

Before contract negotiations, Raytheon and the European firms involved, opened their books to whatever data the NHPLO and the PG's wanted to know vis-a-vis their proposals. There were also to be post-award audits on the non-firm fixed price portion of the contract. The normal NATO practice was followed in carrying out these audits, utilizing both the NHPLO's and the given national government's experts, with heavy reliance on the latter.[20]



Improved Hawk Missile Source: Raytheon

Along the same lines, the NHPLO delegated the quality assurance function to the national government surveillance services, while maintaining an active role at the program management level.

The NHPLO also had instructed Raytheon that the contract could not contain provisions for exchange rate fluctuations. Instead Raytheon and each supplier projected their costs in the currencies involved, and were paid accordingly in a 'basket of currencies'. Therefore, the contractors are fully insulated from exchange rate fluctuations, and the governments pay in a basket of currencies which dampens the amplitude of cost fluctuation, thus reducing their individual risks of foreign exchange losses.[21]

Each of NATO's subsidiary civil agencies, or NATO Production and Logistics Organizations (NPLO's) as their formally called, are basically on their own when it comes to the mechanisms of procurement, (i.e., no single national set of defense procurement regulations are automatically resorted to, while NATO has none). The NHPLO originally insisted on applying the terms and conditions of the General Administrative Clauses and Conditions (GACC) which are in wide use throughout Western Europe, to its contract with Raytheon and all other participating firms. These were the same boiler plate procurement regulations utilized for the previous NATO (Basic) Hawk project with prime contractor SETEL. Raytheon, however, refused to accept them for HELIP, taking the position that they were not well suited for this type of program (nor very artfully drafted for that matter). In the end, for the final NHPLO-Raytheon contract, Raytheon's proposed commercial terms and conditions finally prevailed for the most part. Chief among the several GACC clauses

accepted were the termination provisions. Raytheon's legal consul during the negotiations, Howard Hensleigh, pointed out that the termination clause was accepted because it provided compensation for anticipatory profits in case of termination for convenience.[22]

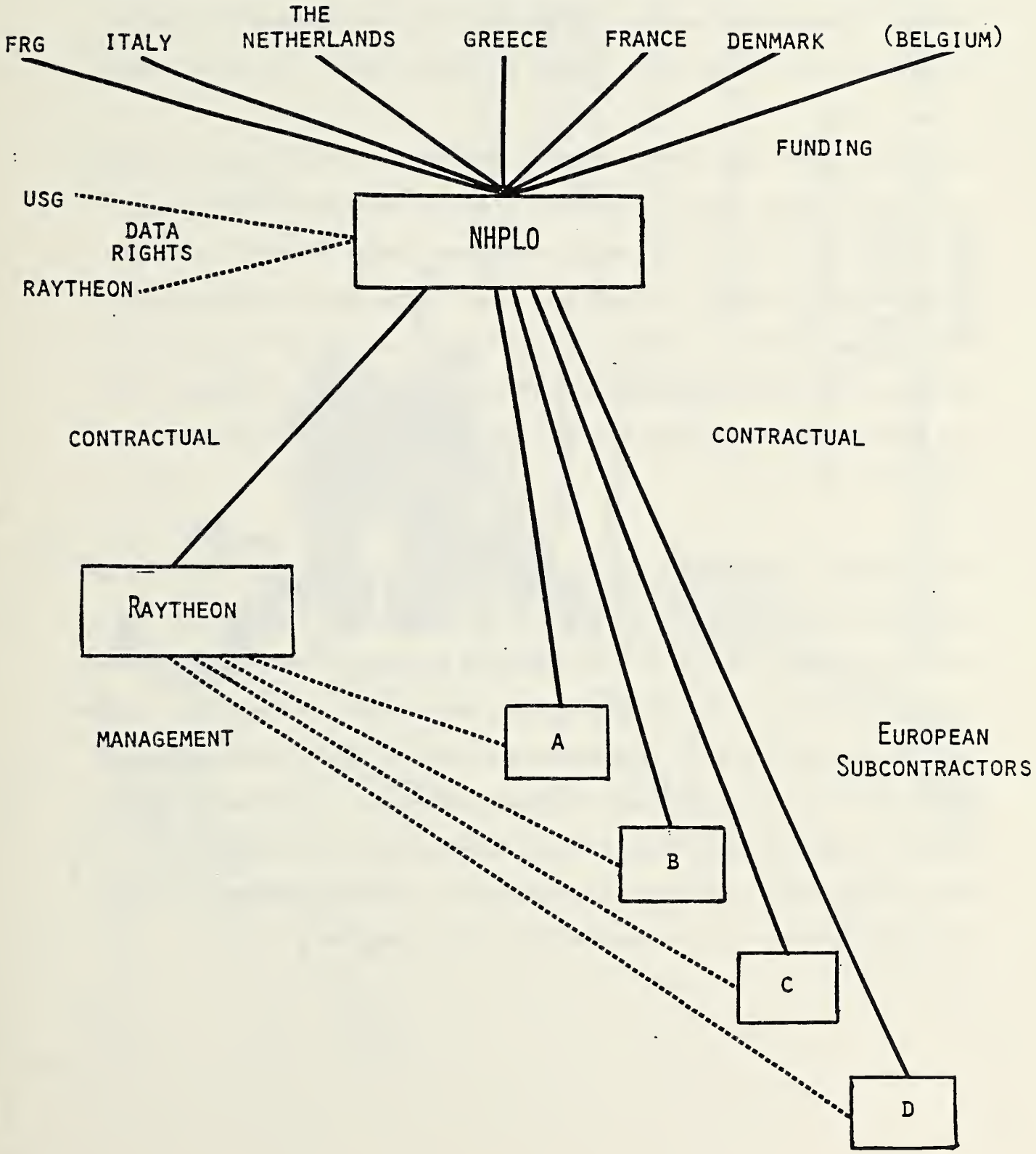
The GACC, however, were adopted wholesale for the contracts with the European suppliers. Though Hensleigh was concerned at the time that this mix might eventually be the subject of a dispute, no problems ever arose.[23]

In addition to the GACC (covering boiler plate terms and conditions) the General Technical and Industrial Rules (GTIR) were also important. The GTIR define the technical requirements to which the European subcontractors work, such as quality assurance systems and final acceptance testing.

Raytheon's NATO Program Manager for the U.S., Bill Mahoney emphasized that a U.S. prime contractor operating in the European environment should be very familiar with both the GTIR and GACC. "For example, regarding the GACC, the contractor must know enough to ask for something initially, otherwise the sub-contractor will later call it extra-scope, and with regards to the GTIR, a U.S. prime must have an idea of what an inspector would be looking for."[24]

In any event, the inter-mix of European and U.S. approaches was one of the factors contributing to the decision to have the NHPLO as signatory for all the contracts with Raytheon's European suppliers." The wide acceptance of the

HELIP (EUROPEAN IMPROVED HAWK)

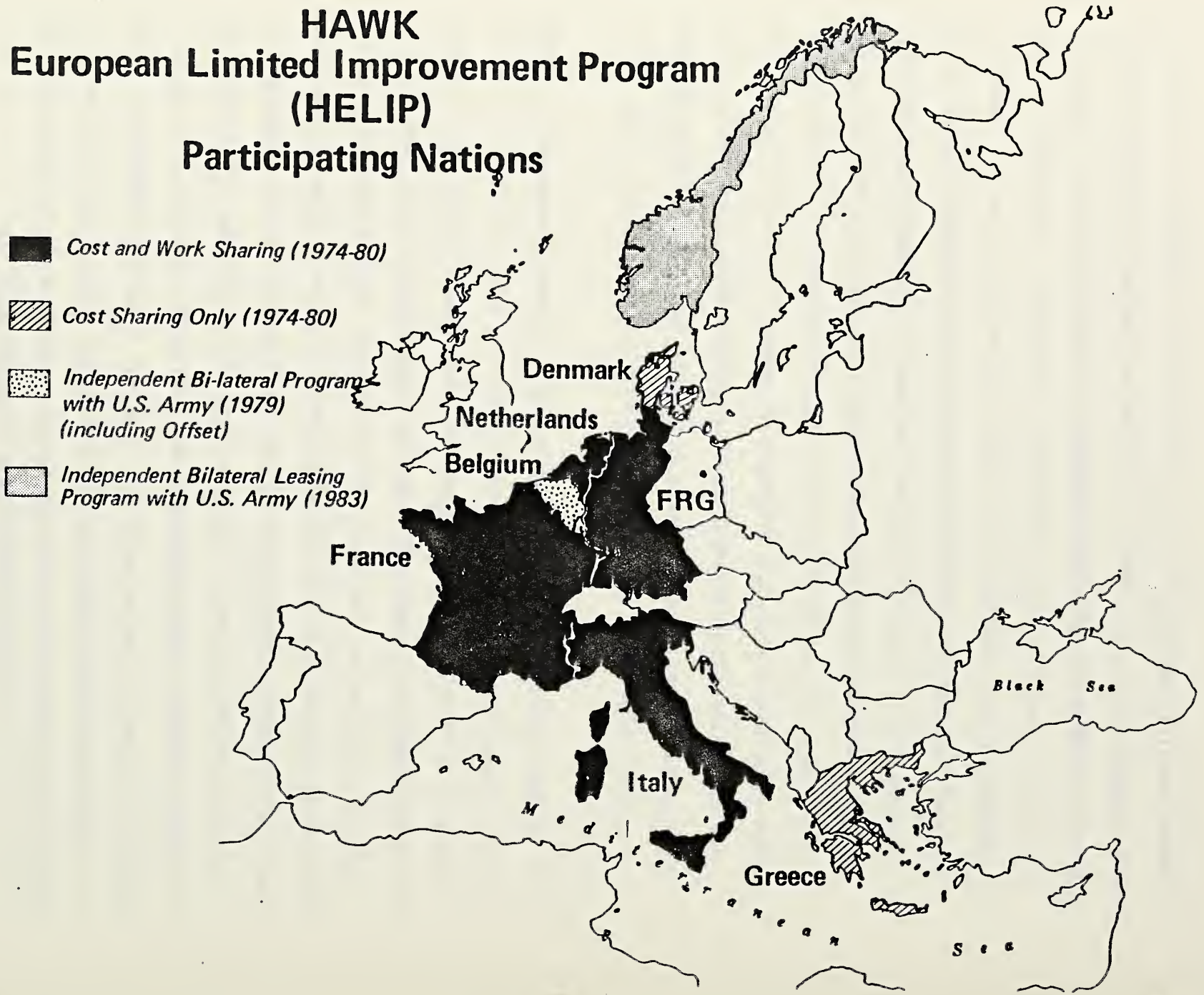


GACC and GTIR in Western Europe and its adoption for HELIP made contracting with European suppliers much easier for Raytheon, substantially reducing the scope of those points open for negotiation. Only the fundamentals such as price, warranty, delivery, and payment provisions needed to be negotiated.[25]

According to Levi, the reasoning behind this unusual contracting relationship was, "the European contract format and structure had evolved over a long period of time, along lines that provided some comfort between the two parties...there being many terms and conditions in the general administrative clauses that we couldn't cope with properly, as a contractor to us. In the interest of consistency, however, at least in a European environment, there was nothing wrong with those contracts being signed directly with the NHPLO."[26]

One additional point (and one which was to be an issue for the NATO AWACS program later in the 70's,) involved protection against third party liability. Instead of indemnification by the purchasing governments (either collectively through the NHPLO, or each national government for its own industry), Raytheon and its European and U.S. subcontractors priced for and obtained commercial insurance. Though indemnification was not resorted to (as it was on NATO AWACS), Hensleigh, said Raytheon would have had no problem accepting an NPLO's commitment to indemnify the contractor. Once the BOD members had agreed and signed, their nations would be fully committed.[27]

HAWK
European Limited Improvement Program
(HELIP)
Participating Nations



5. Organization of the Industrial Effort

Having overall program management responsibility for coordinating the European industrial effort for HELIP, Raytheon set up two wholly-owned subsidiaries several kilometers from where the NHMO is located in Reuil Malmaison just west of Paris . First the Raytheon European Management Systems Company (REMSCO) was established, and then a subsidiary of REMSCO, the Raytheon Technical and Administrative Services (RAYTAS) was set up in St. Cloud. REMSCO was only a shell, while RAYTAS provided program management, including a staff of some 100 people between 1975-1979. RAYTAS staffing tapered off during 1979 and 1980 (when it was finally closed down). Raytheon-U.S. supported RAYTAS for the project (e.g. RAYTAS placed orders for hardware and services with Raytheon-U.S.). In addition to the St. Cloud based staff there were permanent Raytheon technical representatives in vertually all the European supplier plants.

The European firms contracted directly with the NHPLO, not with Raytheon. Legally speaking there were only two parties to each of the contracts, NATO and the individual European suppliers. Nevertheless, Raytheon maintained responsibility for total program performance, with the European firms having been responsible to Raytheon as if in a normal subcontractor relationship. The NATO agency contracted with the European suppliers in such a way, as to allow Raytheon to maintain sufficient control. Signature routing for the NHPLO-European industry contracts and invoices were routed up through RAYTAS management, allowing Raytheon the right to veto payments from the NHPLO to the European contractors. The NHPLO's NHMO General Manager actually signed the contract[28]. In short, although the NHMO had the formal contractual responsibility, subcontractor interface was the sole responsibility of RAYTAS. This contractual arrangement is represented by the figure on the following page.

Raytheon chose the 22 European firms that were solicited to quote for the production, and overhaul and conversion aspects of the program. Among these however, Raytheon did not always have the ultimate choice on which firm was to be selected, since as is typical with NATO programs, there was simultaneously a continual balancing of funding, technology, and production being negotiated at the inter-governmental level within the NHPLO. Although both Raytheon and the NHPLO participated in the negotiations with the European firms (the NHPLO being involved especially in those negotiations covering overhaul and conversion), the scope or work for each firm, the content, and detailed requirements, were generated by Raytheon. The contracts had to be acceptable to Raytheon first, and then would be officially ratified by the NHPLO.[29]

The production program was partitioned as follows between the two sides of the Atlantic:

—

- Raytheon reserved missile guidance and control production to the U.S., since the missile was the most critical item vis-a-vis reliance and performance.

- To the Europeans would be allocated missile assembly, and part of missile production. All the Ground Support Equipment (GSE) production, and the overhaul and conversion of older GSE was also to be accomplished in Europe.[30]

National work and funding shares for HELIP did not strictly adhere to the principles of 'juste retour'—except for Italy. As of the 1974 contract award, the shares were as follows:[31]

	Work %	Funding Order %[32]
U.S.	60.7%	0
Italy	25.3%	22%
Netherlands	7.2%	14%
France	3.9%	14%
FRG	2.9%	40%
Denmark	0	7%
Greece	0	3%

The final Raytheon-European supplier contract structure was not defined until the last of the four proposals and after the final repartition requirements were known and negotiated among the six participating governments. As is evident from the above work spread, Italian industry obtained almost 2/3 of the original work package placed in Europe, with the Dutch, French and Germans sharing the balance. Most of the later Belgian off-set had to be external to the program, as one might expect.

Moreover, there was not a very high correlation between the work performed for HELIP by the individual European suppliers, and that which had been performed during production and follow-on support for the NATO (Basic) Hawk system. The drastically altered repartition requirements, in addition to the capabilities of the firms, determined the work allocation for HELIP.

This time around the Danish and Greek governments paid for their own systems (and not the U.S. through MAP), but their industries share of the work was once again zero. Even though Raytheon did solicit bids from them:

- Greek industry was non-responsive, and;
- Danish industry was non-competitive.[33]

European industry received approximately 40% of the work. The work was divided as follows.

Missile production related items:

-Aerochemie (Italy) - majority of rocket motor;

-SNPE (France) - remainder of rocket motor;[34]

-MES (Italy) - missile safety and arming devices, plus some mechanical items, all for the missile;

-SIGME (Italy) - major part of missile assembly;

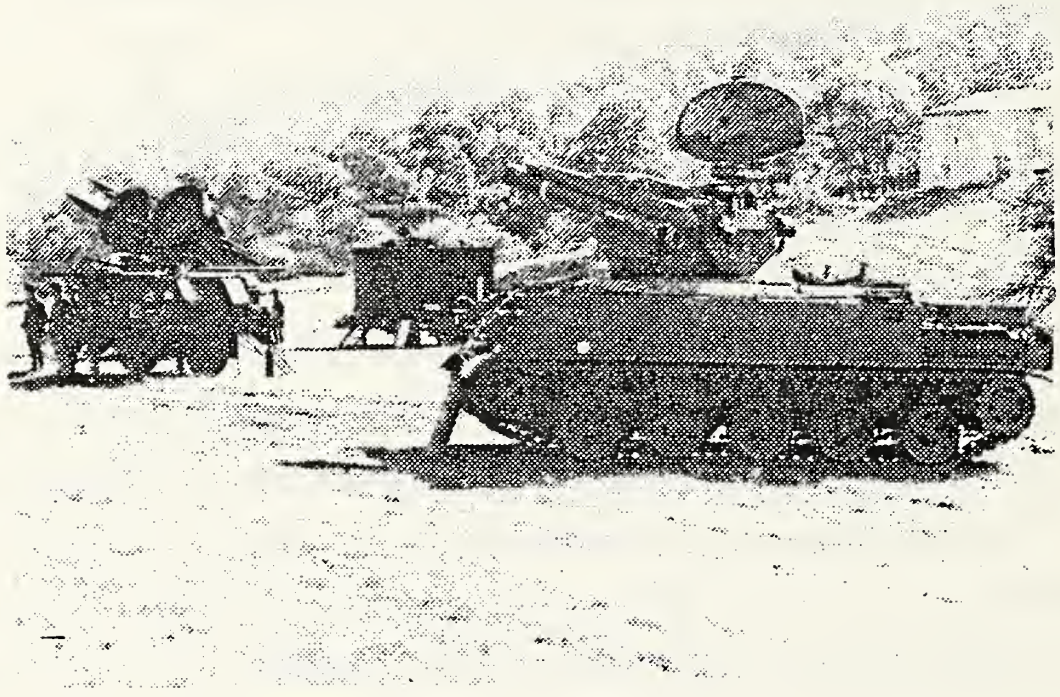
-SODETIG (France) - remainder of missile assembly;

-MBB (FRG) - warhead.

Ground Support Equipment Production:

-FIAR (Italy) - IHIPI radar, ICWA radar, launcher, organization (OME) and field (FME) maintenance equipment kits;

-Selenia (Italy) - IPA radar, battery control central kits, and information coordination central;



French Army exercises, October 1982, with a Roland Short-Range Air Defense (Shorad) missile system, with elements of an Improved Hawk battery visible in the background (Illuminator Radar, Information and Coordination Central, launcher and missiles)

Source: Air & Cosmos

-Aeritalia (Italy)-CCDB;

-AEG-Telefunken (FRG)-improved platoon command post (IPCP);

Overhaul and conversion of old Ground Support Equipment;

- Northline

  -AEG-Telefunken (FRG)-IHIPI radar;

  -Thomson-CSF (France) - IHIPI radar (subcontracted from Telefunken)[35]

  -Fokker (Netherlands) - ICWA radar, launcher, loader, FME 5;

  -Hollandse Signaalapparaten (Netherlands) - IPA radar, launcher, loader, FME 5;

- Southline

  -OTO Melara (Italy) - loader;

  -FIAR (Italy) - ICWA radar, IHIPI radar, launcher, OME, FME;

  -Selenia (Italy) - battery control center, IPA radar, IRO radar, and SICO.

For the production side of the European work there was little duplication within Europe, except in the case of the rocket motors, missile assembly and IPCP. For overhaul and conversion, however there were two lines. One was located in the north for the German, Dutch, French, and Danish systems; and the other in the south (Italy) for the Italian and Greek systems. Excluding the work that fell to the Europeans after the belated January 1979 Belgium decision to procure the Improved Hawk, all Ground Support Equipment was

delivered by the end of 1978. European missile production was completed by the spring of 1980.

6. The Unique Subcontracting Arrangements

Though appearing to have been a systems manager for HELIP with the job of monitoring other contractors providing GFP, the job of RAYTAS was actually that of a standard prime contractor. Even though the formal contractual relationship was not that of a prime/sub relationship, the job was functionally and responsibility-wise very similar to that of a standard prime contractor.[36]

This NHPLO - European industry relationship had benefited from a history of working together since the late 1950's. The NHPLO provides one of the few examples of a multi-project scope for an NPLO,[37] one that can benefit from a well defined contracting authority-contractor interface; one of the key institutional problems faced in NATO projects.

Since the project by project approach usually means setting up new institutional arrangements for each project, working relationships start from scratch practically every time. This means forfeiting for future projects much of the accumulated background knowledge and mutual accommodation of past ones. With each new project, the rebuilding and relearning process must begin again.

As for HELIP, once the NATO Hawk system was in the field (circa 1964), for follow-on work the NHPLO began to circumvent SETEL, the European prime contractor for the project with whom it had developed an unsatisfactory relationship, and went directly to its component firms. This breakdown of the work

meant that the one SETEL-NHPLO relationship was replaced by the multifirm-NHPLO relationships that had been around for a decade by the time HELIP finally took off.

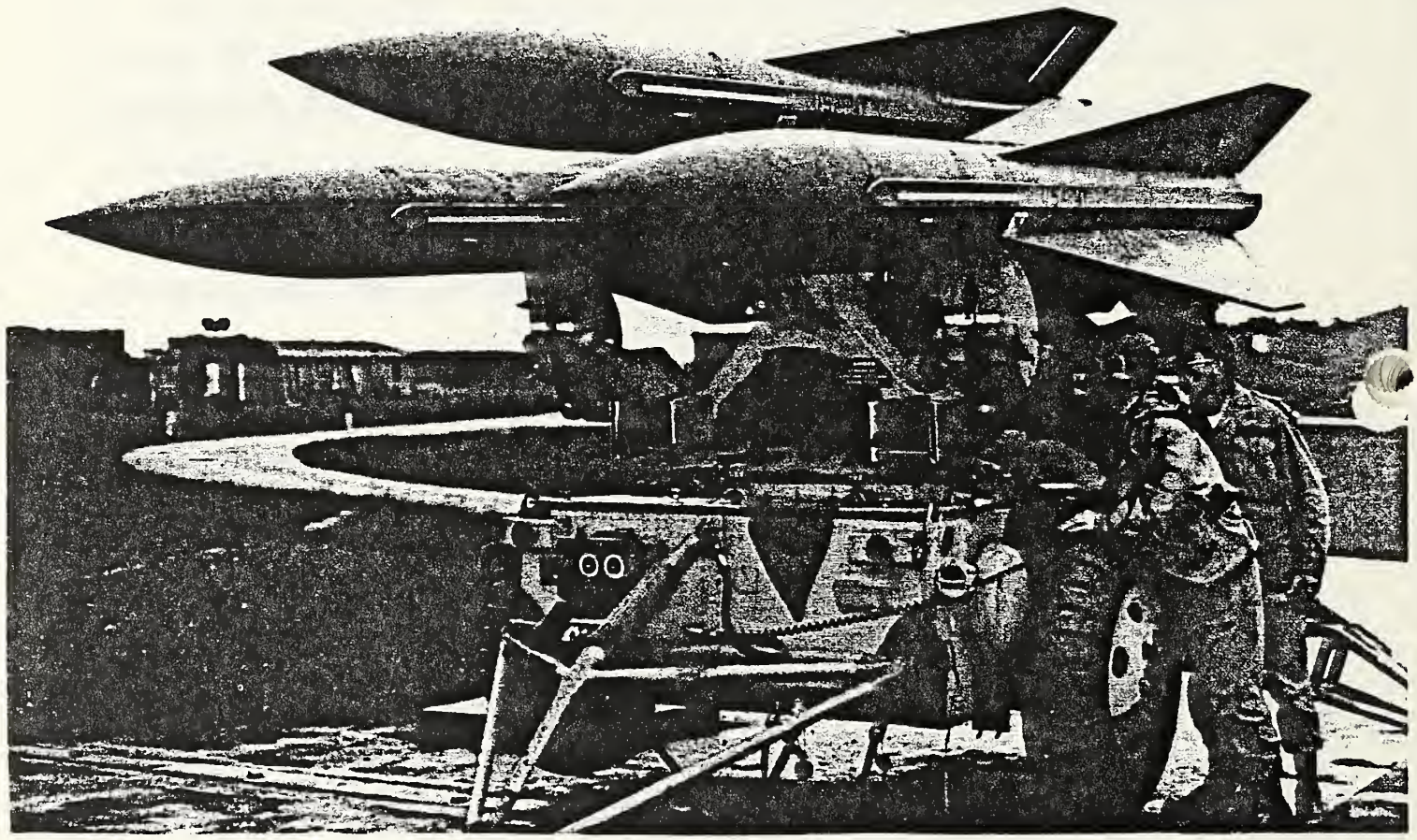
Therefore, one can see why Raytheon would feel comfortable with a prime-sub-contractor relationship such as this, one which at first glance would appear rather bizarre, to say the least.

It was in the area of overhaul and conversion that Raytheon really drew on the NHPLO and its well defined interface with the subcontractors. As one example, Raytheon's European subs were comfortable with granting the NHPLO a much more liberal warranty than any U.S. firm would. For another, there was no way that Raytheon could have quoted a firm-fixed price for any part of a given overhaul task, sight unseen. This is something that, as with SETEL's component firms previously, could be better dealt with on a direct NHPLO – supplier basis, leaving Raytheon out of the loop. The NHPLO was already set up to handle such things as the contracting, audit, invoicing, and inspection functions.

In the area of inspection the NHPLO had long since worked out arrangements with the national government surveillance services. As with SETEL before it though, Raytheon did still have a management role to play, ascertaining after the fact that the subcontractor had done what it said it had.38

7. The Production and Conversion Phase - Several Points of Interest

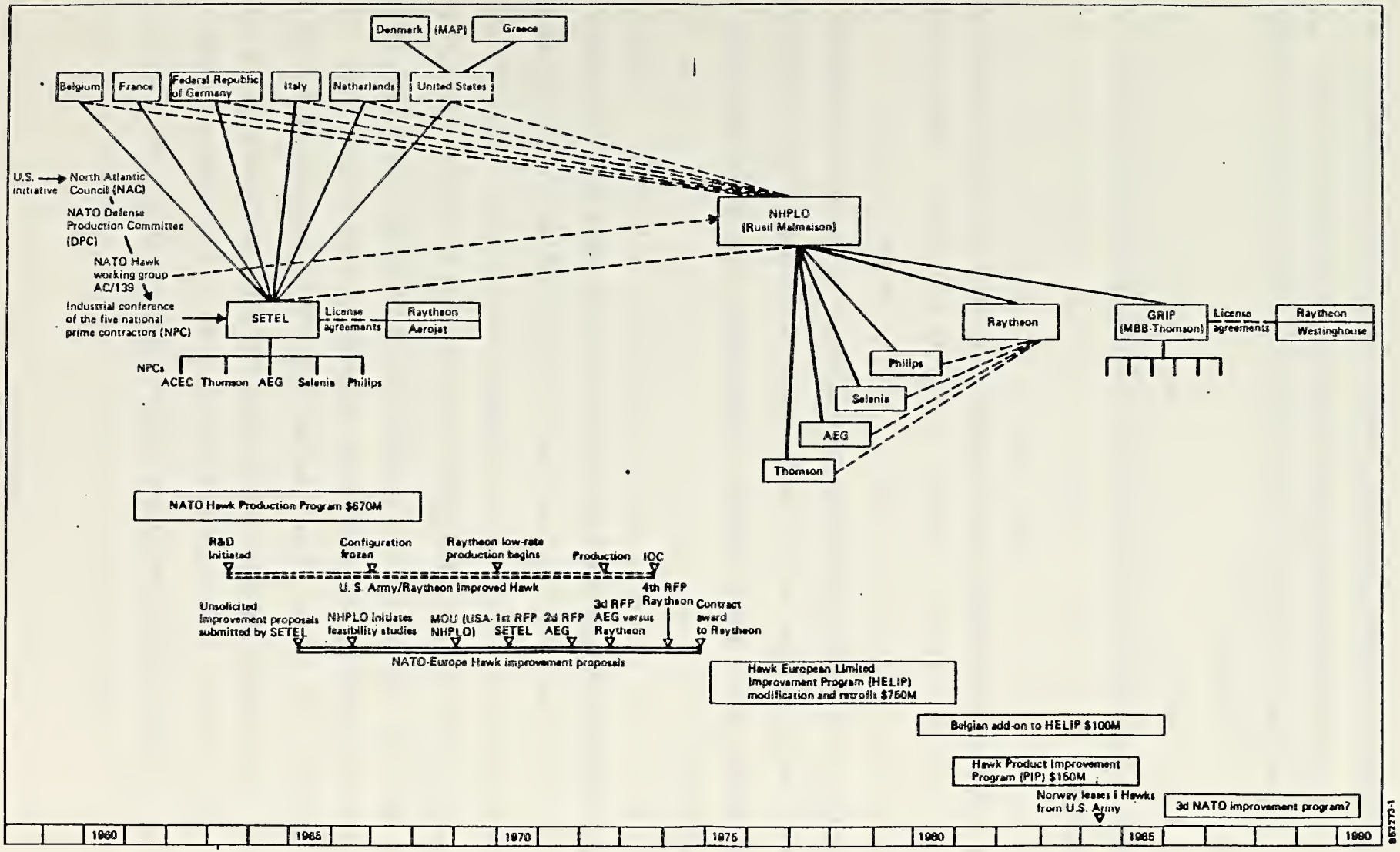
Production and conversion of the Improved Hawk system by this transatlantic grouping of firms went quite smoothly, especially as compared to the previous



Improved Hawk

Source: NATO's Fifteen Nation's

NATO Hawk Production and Improvement Programs



NATO Hawk Project. However, there are several issues that arose during the production and conversion phase of the program that are worth noting for future U.S. led transatlantic production projects[39] falling within this Mode of industrial collaboration.[40]

a. Managing the European Subcontractors and Maintaining the Production Schedule

Raytheon's approach to European supplier problems impacting its responsibility for maintaining the production schedule are worthy of mention. First of all, in order to motivate the foreign suppliers to both respond to proposals in a timely manner and maintain their production schedules, Raytheon followed an approach of assisting them in overcoming any problem areas, while maintaining a situation where any company that was late would be seen as delaying the overall program.[41]

Aid in overcoming problem areas encountered on the European production and conversion line principally took the form of an application of heavy doses of technical assistance and occasionally management intervention. Raytheon and the NHMO substantially underestimated at the beginning the amount of both that would be required. In actuality, technical assistance alone turned out to be about three times greater than estimated. Having to shell out for this unplanned effort with minimal extra compensation, Raytheon was able to lessen the impact by accomplishing much of the technical assistance back in the U.S. A great deal of effort, however, was still required on location in Europe, especially in those cases where strong management intervention was also called

for. In the case of one Italian firm, Raytheon found itself having to send teams in on short notice so often, that in the end Raytheon found itself in a position of having virtually assumed production management responsibility.[42]

In those cases where Raytheon assessed that certain management systems of a supplier were not adequate, Raytheon found that they were generally able to obtain European supplier acceptance of Raytheon's imposition of its own systems. Raytheon attributed this receptiveness to the suppliers looking upon it as part of the technical data transfer/learning experience associated with the program.[43]

In response to the author's question, "Were there any particular problems in dealing with your second tier subcontractors?". Mr. Tucker pointed out that, the general attitude of European industry towards their subcontractors is not one of managing them, but more that of awarding a contract and then expecting performance. RAYTAS had to sometimes "help" them in this role. This was evidentally particularly necessary where historical nationality sensitivities hindered this function.[44]

Additionally, it was pointed out that Raytheon did not have a problem with European suppliers undermining or circumventing its leverage over them as prime, by turning to their government or the NHPLO's staff and BOD. Raytheon had actually been successful in working this route in the opposite direction, working through the NHPLO's staff and the BOD national reps, as well as national government agencies, to maximize their leverage over the suppliers. This proved to be especially necessary as the effort was winding down and Italian suppliers were pleading industrial relations problems, i.e. strikes.[45]

The Deployment of NATO's Integrated Central European Hawk Belt



As a last resort, when a European firm hadn't delivered an urgently needed item there was always the option of providing U.S. manufactured hardware, since there was an alternative U.S. source for everything manufactured in Europe for HELIP. The comingling of assets was allowed between the U.S. program and the NATO program insofar as the U.S. production activities were concerned. Naturally, concurrence by the USG and the NHPLO was required when assets were loaned or exchanged to overcome European program bottlenecks. The most significant case where the need arose involved the lending of a number of missiles to the Europeans for around one year during a period of rocket motor difficulty.[46]

In addition to the usual source start-up problems encountered, strikes were endemic in Italy throughout the project.

Through a judicious mix of assuring high visibility for problem areas, providing technical assistance on a bail-out basis, strong management intervention when called for, and co-mingling of assets, Raytheon was generally quite successful in keeping the project on schedule. Schedule was particularly important as this was an improvement program where deployed hardware was being removed temporarily from the field for overhaul and conversion.

Raytheon's Paul Rotondi offered some general observations with regards to his experience at RAYTAS. First of all, though there were naturally variations from country-to-country, he found the philosophy of contracting, generally not to be as rigid in Europe. This approach is in line with the Continent's codified legal systems, where a given situation is pegged to a general principle

instead of the Anglo-Saxon Common Law/case history approach which often leads to entanglement in a cascading sequence of hair splitting ramifications.

Mr. Rotondi found the hardest adjustment to make involved European firms being not as short term profit and schedule oriented, but instead giving higher priority to employment stability.[47]

b. Flow of Hardware Across Borders

Three issues arose involving the shipping of equipment across borders. One of the earlier educational experiences that Raytheon's subsidiary managing the project, RAYTAS, was to undergo during HELIP concerned administrative problems associated with the paper work involved in moving equipment across borders (especially explosives). Raytheon solution to this problem was simply to hire a European based transportation firm to handle the shipping side of the project, once they had realized that outside help would be needed.

The problem did not end there however. A related problem that arose concerned the blanket waiver of custom tariffs and duties as well as taxes that accompany purchases by NATO and its subsidiary agencies, in this case the NHPLO. Raytheon found itself unexpectedly faced with certain charges, after having been told not to price for them due to the special status of the NHPLO. The claim was for administrative expenses and the fees for handling T1 forms, T2 forms and bonding, explosive permits, etc. Regular duties and taxes were not a problem since they were reimbursed as a matter of course throughout the performance of the contract on a routine invoicing basis.[49]

The European subs, incurring the unanticipated costs, had been passing them on to Raytheon. During 1975 there was a slow accumulation of complaints as the unanticipated costs accumulated and became more visible, tying up increasing amounts of working capital. Finally by late 1975, Raytheon began to tackle the issue, and took on the task of convincing the NHPLO that something needed be done on the governmental side with regards to implementation of the waiver.

Most of the resultant claim was to be for amounts actually paid to subcontractors who in turn paid fees to the custom officials. Costs were incurred as early as 1974 and continued to accumulate through 1979. No claim for interest on the negative cash flow was made. A settlement was finally reached in 1979 as Raytheon was moving into the contract close out phase of cleaning up loose ends. The settlement was formalized in July 1979 for about $800,000, one-half of which went to the European firms.[50]

Another issue over which a problem arose involved European subs and the International Traffic in Arms Regulations (ITAR) which are administered by the State Department's Office of Munitions Control (OMC), in the Bureau of Politico-Military Affairs. The ITAR govern the export of all hardware and technical data on the U.S. Munitions List (Section 121.01 of the ITAR) which includes virtually anything unclassified, or classified, associated with weapons.

Foreign subcontractors in such programs must often resort to U.S. sources for certain parts or materiel. Much as RAYTAS lacked European shipping experience, these European firms often suffer from a lack of knowledge with regards

to purchasing from the U.S. sources. This can even be the case where U.S. based multinationals are involved, as occurred during HELIP. This case involved an Italian firm ordering some parts from a U.S. affiliate, which resulted in a several month delay because of the U.S. firm's lack of the required export license. In setting up such program's and providing the smooth flow of goods and data, lower tier subcontractors can easily fall through the cracks.[51]

c. Contract Administration, Price and Cost Analysis, and Audit

Raytheon's Paul Rotondi provided a description of his activities during his assignment as RAYTAS Manager of Industrial Contracts (1978-1980), spanning the last three years of the project. This will serve to give us an encapsulation of the division of responsibilities between the NATO procurement agency and the U.S. prime contractor. In particular we will look at the working relationship in the area of price analysis and audit. When Mr. Rotondi arrived at the beginning of 1978 to replace Raytheon's Larry Rice, the project had already been underway for four years, being about 80% of the way through production, overhaul and conversion of the Ground Support Equipment, and with missile production about 60% completed.

At this point in time a considerable amount of change activity was going on. This principally involved ECP's emenating from the NHPLO's incorporation of on-going U.S. Army changes, but there were also some Raytheon originated changes in scope resulting from European supplier claims.

With several thousand ECP's being incorporated, and between 10 and 12 amendments per contract[52] (with 1 to 2 contracts per supplier, one for overhaul and conversion and/or one for production), virtually all the contracts remained undefinitized for most of the project, as one open amendment incorporating one or more ECP's built upon another open amendment. There was a major problem definitizing contracts and getting the paper work straight. With a thin audit staff at the NHMO, there was a sizable back-log of undefinitized contracts at any given time. In the interim the parties had to live with Not-to-Exceed prices. This situation would last for a given change on the average one year, and in some cases up to two years. As a result, at the end of conversion and production, close-out of contracts was held-up. This apparently didn't upset the Europeans, though, as they seem to place less priority on rapid close-out.[53]

In its negotiations with the European suppliers, RAYTAS had to rely heavily on the NHMO and its own price analyses. RAYTAS could negotiate prices utilizing U.S. price history, and sometimes rely on competition, but Raytheon could not obtain detailed cost data for a cost analysis. Raytheon could not review the European supplier's books either. Cost analysis and audit involved with ECP's, cost reimbursable items, escalation and fixed hourly rate adjustments was the domain of the NHMO.[54]

The European suppliers would submit their proposals to the NHMO through RAYTAS.[55] RAYTAS would forward these to the NHMO for approval and/or audit after first checking as to the formula. After submittal, if the NHMO decided fact finding for cost data or an audit was required, the NHMO would go

directly to the European firms leaving Raytheon out of the loop. RAYTAS saw the price, but not the detail. The contracts remained undefinitized with N-T-E prices in the interim.

The only exceptions to this rule were those changes where Raytheon, not the NATO agency, paid. Here Mr. Rotondi would demand a cost breakdown as part of the negotiation process. Here RAYTAS obtained hours, rates, and materiel costs over the table, though the suppliers were not actually required to provide them.[56]

8. The Role of NAMSO

Starting in 1965, the NHPLO began to gradually shift its NATO Hawk logistic support functions over to the NATO Maintenance and Supply Organization's (NAMSO)—operational agency, NAMSA, with the latter finally assuming all these support functions in 1975 at the time of the establishment of NAMSO's fourth operational center. The NHPLO and the NAMSA Hawk operational center are colocated, at Rueil Malmaison, near Paris. This involved the same NATO staff, who were simply trans-ferred, without relocation, from one NPLO's jurisdiction to the others.

In 1975, as the HELIP effort began to pick up, the NHMO finally transferred the last of its Hawk logistics support responsibilities to NAMSA, ending a decade of gradual transition. Since then there has been a theoretically clear division: NHMO in Paris handles production; and NAMSA, in Luxembourg, handles all support once the system is in the field. However, there was originally

some doubt when the NATO Hawk European Product Improvement Program (PIP) picked up in 1979 as to whether it would be NHPLO or NAMSA managed.

One noteworthy aspect of Hawk Weapon System Partnership (WSP) within NAMSO is the periodic utilization of protectionist margins to promote the industries of the seven participating European nations. If less than 15% above a bid from a nonparticipating nation's firm, i.e. the U.S., a European firm wins outright. If none are within this margin, any European firm that was within 15-30% of the U.S. bid had the right to match the U.S. bid. However, this discriminating margin has not placed Raytheon at a significant disadvantage and has not cost them much in the way of potential business.

NAMSA's procurement policies generally push the allocation of work on a basis which is as proportional as possible with that of program funding, i.e., U.S. suppliers are competed with European suppliers wherever feasible as part of the on-going efforts to develop and maintain European sources for the systems supported (which are primarily U.S. systems in the inventory of several European armed forces).

Raytheon and other U.S. firms are involved primarily with spares procurement. Very little actual post-delivery maintenance support is being provided by U.S. firms to NAMSA, except in the area of the missile.[57]

Raytheon has found NAMSA-related business difficult to administer. In Mahoney's opinion, if a contractor was not looking at a large volume of follow-on business, the reporting, certification, and so forth, probably would

make doing business with NAMSA overly burdensome. Furthermore, NAMSA reportedly falls into the posture of treating everyone as a vendor, a role Raytheon is not used to find-ing itself in.[58] Here again, the General Administrative Clauses and Conditions (GACC) have prevailed, with Raytheon by and large locked into NAMSA's Terms and Conditions (which are based on the GACC).

9. HELIP - Lessons Learned

The lessons learned at Raytheon from the HELIP experience, as offered by Levi were:

- The importance of having a successful program in the U.S. preceding the transatlantic coproduction effort;
- Performance claims were backed by an extensive U.S. test program;
- The value in having a mature program, with strong home government support, before expansion to a multinational program;
- A successful multinational program requires strong industrial program management;

- Although Raytheon signed one contract with the NHPLO, the NHPLO represented six customer nations, each with a different set of pressures and requirements. Therefore, it is important that a contractor be prepared with alternatives for various mixes of national participation that can allow for effective compromises within such a highly fluid grouping of customer nations.

Raytheon's Bill Mahoney emphasized the following lessons learned from the production phase:

- Importance of being set up to provide technical assistance and strong management intervention on short notice, in case required, in dealing with foreign subcontractors;
- The importance of dealing in a timely manner with the administrative aspects of international shipping during production as they impact on customs- related paper work and ITAR.
- The need for a U.S. prime operating in the European environment to be familiar with the General Technical and Industrial Rules (GTIR) and General Administrative Clauses and Conditions (GACC).
- A U.S. firm should be looking at a significant volume of follow-on business with NAMSA, if it is to justify the reporting, certification and so forth, that doing business with NAMSA calls for.

The author would like to add to this list:

—

- An openness to working in an environment where one must be willing to move outside conventional national defense contracting practices, the case warranting, as occurred here in the NATO procurement agency-U.S prime contractor-European supplier relationships;
- The sequential business and production relationships represented by the evolution over the past 24 years of NATO Hawk, from the original license production program (1958-1967), to the Hawk European Limited Improvement Program (1974-1980), to the Belgian add-on (1979-1980), and most recently, the Hawk European Product Improvment Program (PIP) (1980-1984), along with the roles of the two NATO procurement agencies, the NHPLO and NAMSA, are of import to the evolution downstream of other NATO projects

wherein U.S. systems are introduced into the European inventories through multi-national production schemes (i.e., Mode #2 with such projects as Hawk, F-104G, Patriot, AIM-9L Sidewinder, and Mode #7 with the F-16 Multinational Fighter and NATO AWACS).

- Given the diffuse set of hierarchical relationships experienced in such transnational projects, in order for a prime contractor to effectively carry out its sub-contract management responsibilities a balanced application of the following approaches is required:
  - a familiarity with the foreign governments' and suppliers' ways of doing business along with a willingness to meet them half-way when feasible;
  - a need to work closely with and through the suppliers national government when necessary;
  - Close tracking of work progress, remaining ready to bail-out suppliers through the application when required of judicious doses of technical assistance, strong industrial management, and the alternative of hardware off the original production line (when dealing with second sources), while maintaining an awareness of the national sensitivities of those involved.
- The benefits that can accrue to all concerned when the institutional relationships established between an international contracting authority and its contractors are allowed to continue for follow-on projects, building upon these relationships, instead of building up from scratch for each new project.
- In any operation requiring unanimity, unfortunately, the last hold out can demand a pretty steep price for its participation, as did Belgium for HELIP.

10. Sequel

A later development concerning this project was covered in Chapter 11, under Mode #6 of industrial collaboration, involving primarily a U.S. government offset provided to Belgium in early 1979, in return for its finally adopting the Improved Hawk. The Belgian's also bought their Improved Hawk systems through the NHPLO through an add-on to the 1974 contract, of some five years earlier.

A more recent collaborative sequel involving this system stems from the European decision in the late 70's (the nations operating through a special NATO High Level Group in Brussels) to replace only their NIKE systems with the medium and high altitude Patriot (see Chapter 7). This is unlike the original U.S. plan, wherein the Patriot was to be adopted to replace both the Improved Hawk and NIKE systems. The U.S. too, though, has since backed off on its plan to replace the Improved Hawk with Patriot. The system now has an indefinite operational life with the U.S. Army.

The Europeans consequently will replace their high altitude Nike SAM systems with Patriot (as will the U.S.), while for the medium altitude SAM requirement, they will follow a two pronged approach. The first prong involves a short term solution which would lead to one or more European improvement programs to prolong the usefulness of the existing Improved Hawk systems. The second prong will involve a longer term solution wherein France, the FRG, and the UK will jointly design and develop a totally new system to replace the European Improved Hawk system as well as the British Improved Bloodhound

system. The new European medium altitude system is currently called TRI-SAM. The pre-feasibility study was completed in June, 1981 and a feasibility study was scheduled to begin in mid-1982.[59]

The above set of decisions resulted in the fourth NATO Hawk related collaborative arrangement along the lines similar to the original NATO Hawk program (Mode #2 of industrial collaboration). The NHPLO awarded a $150 million contract in November, 1979 for the project, called the Hawk European Product Improvement Program (Euro-PIP) to a Franco-German consortium. Groupement pour la Realisation Industrielle du Programme (GRIP) was established by MBB and Thomson-CSF, as the parent company to oversee the modernization of NATO's European Improved Hawk systems.[60]

Raytheon's role has evolved over the last two decades from one of licensor and provider of technical assistance for the NATO Hawk program, to one of prime contractor for HELIP, and back again to the original role for the Hawk European Product Improvement Program (PIP). The Improved Hawk has involved five Technical Slices since the end of the original NATO Hawk program (ending in 1967). The first four within the framework of HELIP (Hawk European Limited Improvement Program) launched in January 1974, and the fifth with Euro-PIP launched in late 1979.

For the fifth Technical Slice (post-HELIP), Raytheon determined that they could be considered a serious contender if they teamed with a European firm, with Raytheon in the role of subcontractor. Raytheon opted to go this route,

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HAWK PRODUCT IMPROVEMENT PROGRAM



For NATO-HAWK Production and Logistics Organization

HAWK PIP

Production + Installation + Integration

A success for industrial cooperation in Europe; Companies in France and Germany as well as Belgium, Denmark, Greece, Italy and the Netherlands participate in this program.
The first batteries have been upgraded and returned to operational status on schedule.

GRIP

MESSERSCHMITT-BÖLKOW-BLOHM GMBH
DYNAMICS DIVISION
THOMSON-CSF
DIVISION SYSTEMES ELECTRONIQUES

teaming with MBB. The two firms proceeded to set up a program which encompassed an industrial team including all participating nations. In late 1979, MBB-Raytheon was selected over its competitor, a Franco-German team made up of Thomson-CSF and Telefunken, by a vote of 6-to-1 on the BOD. The decision required unanimity, France being the only dissenting vote. MBB and Raytheon were told that the French govern-ment's veto would hold unless Thomson-CSF could be taken in as a third and co-equal partner. MBB and Raytheon decided this was not feasible. The FRG then sided with France, and MBB switched teammates. The selection of the Thomson-MBB team as the prime contractor for the four-year, $150 million Hawk EURO-PIP was announced shortly thereafter in late November, 1979.[61]

Improvements which have already been qualified in the U.S. for its own Improved Hawk systems, are to be incorporated into those of the seven European user-States (Belgium, Denmark, the FRG, France, Greece, Italy and the Netherlands).

The program will have a duration of 4 years, and this time around, the industries of all seven countries concerned are receiving subcontract work from the Paris based GRIP roughly proportional to their financial participation in the program.[62] The work sharing program adopted was the one originally developed by the MBB-Raytheon team. This included a vertical instead of horizontal slicing of work packages, with absolutely no redundancy, e.g., work was assigned so that there would be only one source for each generic item instead of by sub-assembly wherein there would be multiple sources within the program for similar items at the lower tiers. Raytheon and Westinghouse,[63] from whom

license rights have been obtained, are providing technical support to the participants, i.e., documentation, along with technical assistance and component parts procured under Basic Ordering Agreements.

EURO-PIP was inter-related with the Belgian Improved Hawk procurement and offset, in that Italian industry, in return for its share of the work generated by the Belgian add-on to HELIP, handed over its share of EURO-PIP to Belgian industry.

At the end of 1980 the NHPLO was on the verge of finalizing another major procurement, but this one was through Foreign Military Sales (FMS) channels. The Defense Department informed Congress of a proposed letter of offer (LOA) to the NHPLO involving a $120 million coproduction arrangement. The participating Europeans were to manufacture up to a total of 29 Litton Data Systems AN/TSQ-~~73~~ air defense command and control systems, called Missile Minder.[64] Representing an expansion in the purview of the NHPLO's activities, the Missile Minders will provide command and control for not only the European Hawk surface-to-air systems (medium altitude), but also for the European Nike Hercules surface-to-air systems (high altitude).[65]

The NHPLO is also one of the alernative candidates under consideration for the government management role in the upcoming NATO-Europe Patriot SAM system program covered in Chapter 7.

B. F-16

1. INTRODUCTION: The Mode of Industrial Collaboration Adopted for the F-104G Replacement

In June 1975, after 13 months of evaluation, a purchasing consortium of the four small Northern European NATO member states—Belgium, Denmark, the Netherlands, and Norway—selected the General Dynamics F-16 over its competitors, France's Mirage F-1 and the Swedish Viggen. As a prerequisite for eligibility, each of the selling national teams had had to agree to considerable industrial participation for the four selecting countries.

The F-16 was to replace the F-104G's Starfighters and smaller quantities of several other aircraft in the inventories of the four European Participating Governments (EPG's). The previous generation's F-104G's had been procured on an entirely different basis in an earlier era. The two smaller nations, Denmark and Norway, had been provided their small number of Lockheed built F-104G's (and in the case of Denmark F-100's as well) through the U.S. Military Assistance Program (MAP). Belgium and the Netherlands procured their F-104G's as part of a combined European license production program including the FRG and Italy as well (Mode #2 of industrial collaboration).[1] Belgium and the Netherlands also received a U.S. MAP subsidy equivalent to 25 aircraft each for their 100 and 120 aircraft orders, repectively, and benefited from the economies offered by a 949 aircraft program, made possible by the FRG's large order.

This time around, however, the two larger nations, the FRG and Italy, had opted for joint development (Mode #3 of industrial collaboration) of their own aircraft, the MRCA Tornado, along with the U.K. The U.K. had given up on its earlier attempt to unilaterally develop its future fighter (the TSR-2) in the early 60's, and the subsequent two year try at jointly designing a fighter with the French (the AFVG) from 1965-67 (see Chapter 13).

The Netherlands and Belgium had been early dropouts of the MRCA consortium in 1968-69, being unwilling to pay the premium required for, and assume the risk of, partipating in development. They also knew full well that their idea of the requirement would be submerged in what would be basically a British-German program. Individually, the four EPG's had little or no clout. Even their combined F-16 orders, only came to 348 aircraft or just over 1/3 of the previous F-104G project's. Therefore, this time around there would be no economies of-scale and German largesse that would justify license production along the lines of Mode #2.[2] The four smaller northern European NATO members thus opted to strengthen their positions by forming a consortium in 1974 to shop for the best deal with regards to price, performance, and industrial offsets. This turned out to be an arrangement, wherein the F-16's would be produced in Europe along the lines of Mode #7 of industrial collaboration, i.e., a U.S. led multinational production consortium.

Concurrently, 1974 saw a reorientation of U.S. priorities away from Southeast Asia and back to NATO-Europe and the exigencies of NATO standardization.

F-16 Participating Nations — Production



Cost and Work Sharing Integrated Production Program

Independent F-16 procurement and offset programs

F-18 procurements with offset (in lieu of F-16)

Norway

Denmark

Netherlands

Belgium

Black Sea

MONACO

SAN MARINO

VATICAN CITY

GIBRALTAR

MALTA

Mediterranean Sea

2. The USAF Prototype Competition

The lightweight fighter had its genesis in 1970 when, with the abandonment of the "Total Package Procurement" concept, the DoD directed the Air Force and Navy to nominate innovative programs for prototyping. The object was to reverse the mushrooming costs of buying weapons. The reinstituting of prototyping was seen as a means for identifying and solving complex technical problems at relatively low cost and thereby reducing the cost exposure inherent in paper projections.[3]

From a list of a half dozen candidates for prototyping, the DoD chose the lightweight fighter, the advanced medium STOL transport (AMST - Boeing and McDonnell Douglas), and the advanced tanker cargo aircraft (ATCA - again Boeing and McDonnell Douglas). Though there was no visible requirement for a new fighter aircraft in the DoD inventory—the F-15 and International Fighter Aircraft Program (F-5) being considered adequate—there was a known requirement for a new fighter in the European arena that would fall between these two in performance and cost.

The Lightweight Fighter (LWF) Prototype program was launched in May, 1971. In response to the RFP, six designs were proposed by five contractors: Boeing; General Dynamics; Lockheed; LTV; and Northrop. The latter firm, Northrop, responded to the RFP with two proposals, a single engine and a dual engine configuration. In April 1972, General Dynamics was awarded a $38 million contract to develop and produce two YF-16 prototypes and Northrop $39 million for two dual engine YF-17's. The remainder of the authorization went to General

Electric for its YJ101 to power the YF-17 and to Pratt & Whitney for its F100 engine to power the YF-16 (the F100 already being in production for the USAF's F-15).

Then the U.S. Navy came into the picture with its FY 75 budget request for VFAX to complement its expensive high performance Grumman F-14 Tomcat. Congress insisted at the time on commonality between the two services' aircraft. The Navy was instructed to consider one of the two USAF designs for its Air Combat Fighter which led to the two contractors forming teaming agreements: GD with LTV, and Northrop with McDonnell Douglas, each new partner being responsible for designing a version of the prototypes for Navy use.

The Air Force took the initiative in the joint Air Force/Navy LWF program and developed a list of prototyping ground rules:

- Existing force structure was not a constraint;
- There would be a minimum of military specification requirements;
- Funding would be limited;
- There would be a competition before the system could go into production, although there would be no production commitment;
- There would be minimum initial performance goals, and;
- The system would be designated "Y" instead of "X" because it would blend off-the-shelf and experimental technologies.

A gap between OSD and the Air Force, though, soon surfaced over the governing philosophy to be applied to the LWF program. The Air Force viewed the LWF as a pure technology expansion program with no inventory objective, while the

design to cost forces in the OSD viewed it more as one having production potential and was concerned that, unless there was heavy use of off-the-shelf technology, new technology requirements would adversely impact availability.

The concept for the program was essentially one of the government following a hands-off approach, permitting the contractors wide latitude to carry out prototype development with few Air Force managerial restraints. The Program Office would simply monitor the contractors' progress. Set up in September 1971, the initial manning of Program Office was 17, with one co-located engineer.

Designed for the most demanding tactical air mission, air superiority, the LWF also had the characteristics to fly intercept, interdiction and close air support missions. What the Air Force wanted was an aircraft that could outmaneuver Soviet fighters where air combat is fought—at altitudes up to 30,000-40,000 feet and Mach numbers of 0.6-1.6. Warsaw Pact forces had large numbers of air-to-air fighters, MiG 21J's and MiG-23B's, that operated in this regime. The multimission LWF was also designed to intercept MiG-23S and Su-19 ground attack aircraft.

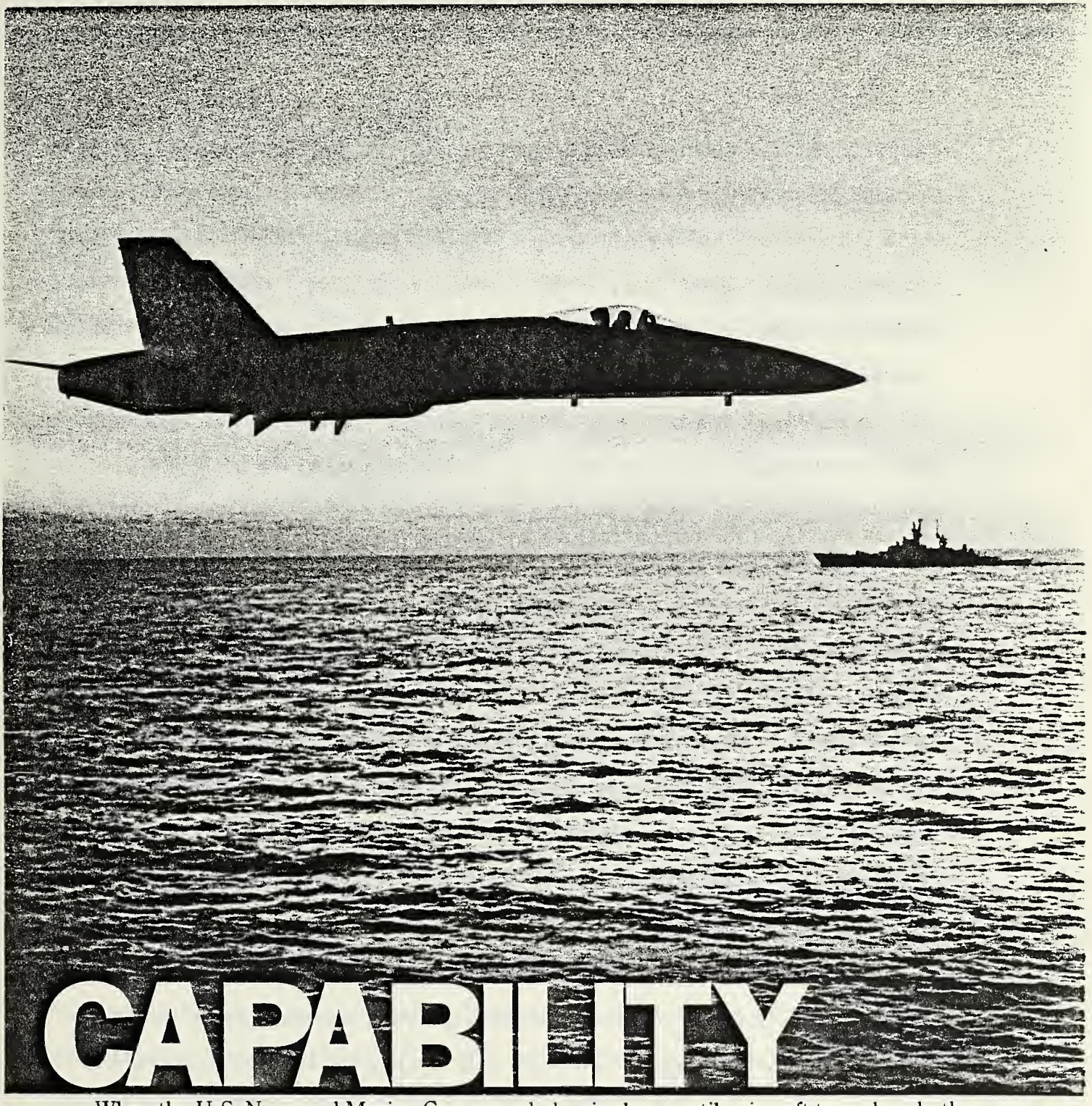
The single Soviet front-line fighter that the LWF was not designed to match is the MiG-25-A Foxbat, a Mach 2.8 aircraft that has a service ceiling above 80,000 ft. The objective for the LWF was not to optimize at a point in the sky, but across the range of air combat. So the critical design goals of the LWF became maneuverability (i.e. turning rates and acceleration) and range. On this latter point, the F-16 was to have 2½ times the radius of action of the F-4.

In late 1973/early 74 things started to develop at a fast pace. First, the Arab-Israeli war of October, 1973 brought U.S. tactical planners to the realization that numbers of fighter aircraft are as critical as top performance in battles to win and maintain air superiority. This was to be the key motivating factor contributing to the 1974 decision to develop one of the LWF prototypes from a technology test bed into a production aircraft that would supplement the expensive top performance F-15 and help to off-set the Soviet Union's numerical advantage in the air.

Secondly, when performance and financial figures came in, in early 1974, previous scepticism within the DoD and the USAF vis-a-vis the LWF concept evaporated. Following a February 1974 guidance from the Secretary of Defense stating that . . . . "The Air Force should program funds for development of a low cost fighter . . . ." the USAF created a Tactical Fighter Modernization Study Group in March. The group concluded that cost considerations and performance potential suggested complementing the replacement of the F-4's by the F-15's with an operational derivative of the LWF.

Though there was no evidence that the surfacing interest of several smaller European nations in replacing their F-104's had any impact on the missionization of the LWF for the USAF (this version being called the Air Combat Fighter) the group did point out the potential foreign military sales benefits to the U.S. of European involvement.

In late May, 1974, a month after the Tactical Fighter Modernization study had been completed, developments on both sides of the Atlantic began to move



When the U.S. Navy and Marine Corps needed a single versatile aircraft to replace both the F-4 Phantom and the A-7 Corsair, they selected the multi-role F/A-18A Hornet.

The F/A-18A provides dogfight capability superior to any tactical fighter in the Navy inventory.

Light attack capability greater than any airplane in the Naval attack community.

Reliability projected to be three times that of either of the two aircraft it will replace.

Northrop is associated with McDonnell Douglas, prime contractor to the U.S. Navy, for development and production of the Hornet. Northrop will be prime contractor for derivatives designed for land-based operations.

The F/A-18A Hornet. More reliable. More capable.

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Making advanced technology work.

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towards a nexus. A delegation of representatives from four European nations — Belgium, Denmark, the Netherlands and Norway — having formed a purchasing consortium for an F-104G replacement, came to the U.S. for a briefing. The Europeans made it clear that, in addition to a new plane, the price of eligibility for competing with the French and Swedish offers would involve adequate industrial compensation, as well as the U.S. selecting either the YF-16 or YF-17 within the following four months. The DoD accepted the requirement for industrial offset, but faced a problem on speeding-up the U.S. source selection, a decision that was not scheduled for another year; May, 1975. The issues faced were: how much could the U.S. evaluation process be shortened; and how could the European requirements be balanced with those of the U.S. Navy?

The Air Force did move source selection forward from May up to January, 1975, but at that time the U.S. Navy was unable to commit and bowed out of the program. The edge in the selection went to General Dynamics, primarily because of relative performance factors. As it turned out the Navy subsequently selected in May, 1975, the McDonnell Douglas/Northrop YF-17 whose operational derivative was redesignated the F-18. So, for full scale development what was originally to have been a joint USAF/Navy program, became a joint USAF/four European Air Forces program, with the U.S. Navy going its own way with the alternate prototype.

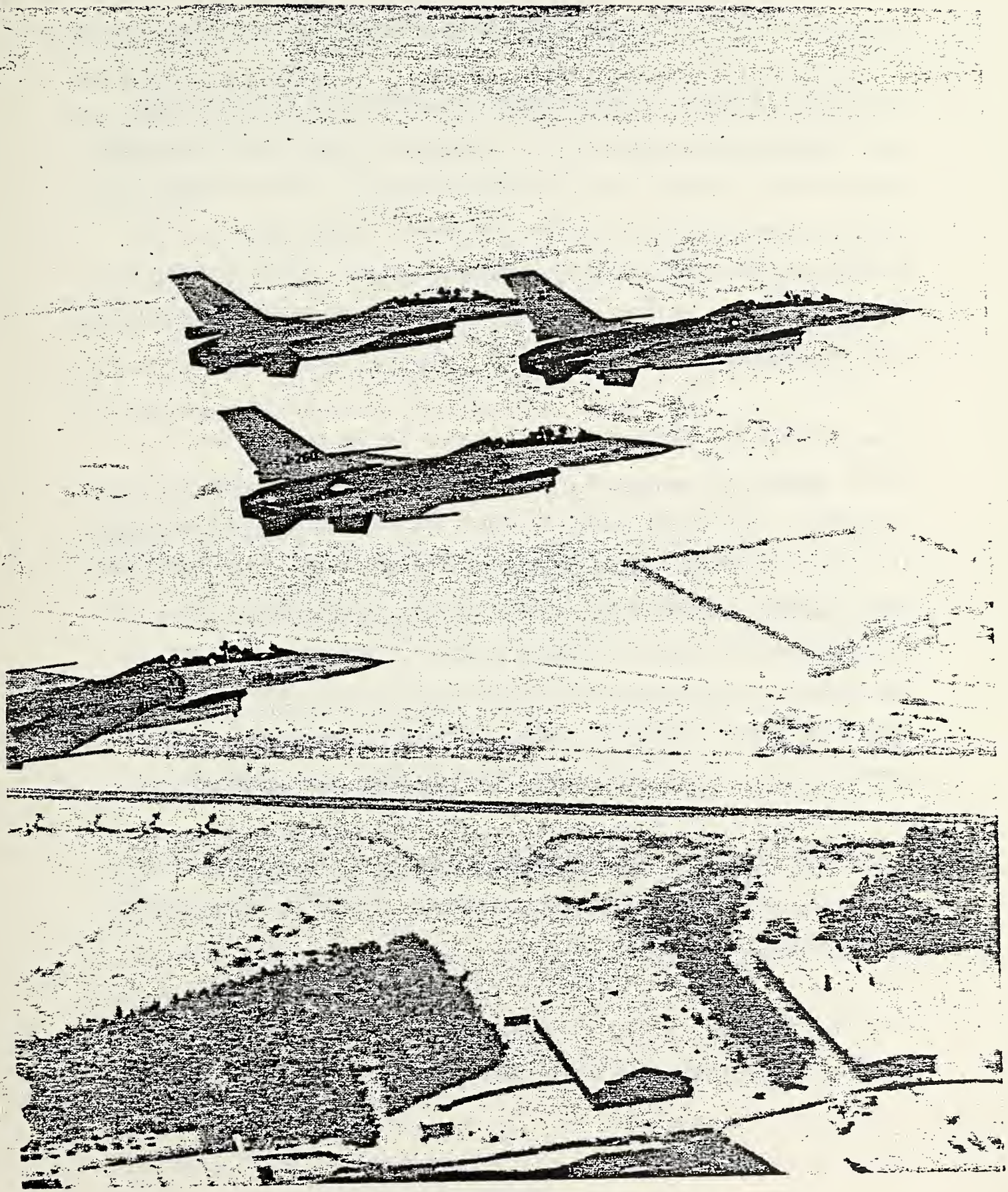
Meanwhile; in early September, 1974, after several months of negotiations during which the four European governments hammered out the DoD's initial commitments that would accompany consideration and selection of the U.S. fighter, the Air Force's Aeronautical Systems Division (ASD) had issued the RFP for Full Scale Development and Production to GD and Northrop, including, inter

alia, an ASD cover letter, proposal preparation instructions, and a model contract. These documents, reflecting the fundamentals of the U.S. offer to the European consortium, instructed the competing contractors to submit their co-production plans. Receipt of these instructions resulted in intensified efforts on the part of GD and Northrop to line up potential European partners. They perceived this as a vital part of the competition, one for which the Source Selection Criteria established a grading category that scored the reasonableness and adequacy of the contractor's co-production planning.

Representatives of the four European governments took part in the source selection. Though not yet having committed to a U.S. system over the competing French and Swedish systems, they insisted on being treated as partners, not foreign military sales customers. They were therefore, allowed to participate as working members of the evaluation team, not observers. The Europeans had input, even though the U.S. made the decisions. The expertise provided by them was heaviest in engineering, but also included finance, military operations and management. After the five-country evaluation, the European representatives came to the conclusion that either aircraft would be acceptable. This opportunity to participate in the U.S. source selection process, as opposed to the more conventional marketing approach followed by the French and Swedish with their individual aircraft, was reportedly, in the view of SPO officials, a turning point in the European competition.

With the U.S. selection of the YF-16 in January, 1975, and the Navy's dropping out of the program, the USAF was ready to proceed with the full scale development and procurement of an operational derivative of the prototype. The

four European nations, however, had still to make up their minds as to whether an American, French or Swedish fighter would be adopted.



3. The Offset Battle in Europe

In February, 1974, when Belgium, Denmark, the Netherlands and Norway had jointly established a requirement for replacement of their F-104G's and other similar vintage fighters, they estimated their needs as ranging between 325 and 380 aircraft. On May 2, the four Ministers of Defense formed a Joint Military Steering Group to evaluate candidate aircraft. Though the Belgian Minister wanted an immediate selection, the other three persuaded him to delay until September.

On May 20, 1974 the four nation steering group invited the governments of France, Sweden, and the U.S. to submit bids for their common selection of a new fighter. Over the following 13 months the three nations competed in an all out high-stakes poker game for what came to be labeled by the French newspaper, Le Monde, "le marche du siecle" (the arms deal of the century). This relatively small procurement appeared to potential producers to be the "tip of the iceberg" for a new generation of NATO and world-wide fighters. The consortium contracts coupled with a contract from their own armed forces could be expected to give a contractor a significant advantage over competitors.

The U.S. entry was to be the Air Combat Fighter, a missionized fighter to be derived from one of the two competing Lightweight Fighter prototypes offered by General Dynamics and Northrop.

The French entry was the Dassault-Breguet single engine Mirage F-1E, an interceptor with a secondary attack role. The F-1 was already operational, the

first squadron had been commissioned in January, 1974. The French Air Force had placed orders through 1977. An even larger number than the French order had been sold to other nations. The proposal for the 'E' Model included incorporation of a new engine, the SNECMA M53, not scheduled to fly until the end of 1974.

The Swedish entry was the Saab-Scania single engine Viggen, already operational in the Swedish Air Force, which had one attack wing funded and planned to fund the two remaining wings by 1977. The advanced JA37 fighter version was expected to be operational in early 1978.

The themes behind each of the three competing national offers might be summarized as follows:

- The U.S. pushed NATO Standardization and stronger transatlantic ties, especially since the U.S.A.F. would be basing at least 300-400 F-16/17's in Europe (compared to the small number of F-1's currently in, or planned to enter, France's inventory). France was a member of NATO, but not of its integrated military command structure;

- The French worked hard on the concept of an evolving European aerospace industry and the major impact the decision would have on furthering it, while lessening the dependence of the European aircraft industry on the U.S.

- The Swedes being both outside of NATO and the European Economic Community (EEC) had no real options in the way of political appeals of the nature of those of the U.S. and France, nor did they have as broad an aerospace

industry base as the other two, and so instead, made their play on the basis of a set of packages of industrial offsets for each nation that included major non-aerospace elements as well. Sweden's best chance was considered to lay in a collapse of the consortium that would at least allow them to win over one or two members.

In early June, 1975, Denmark, the Netherlands and Norway selected the U.S. contestant, the F-16. Belgium demurred, but agreed to go with the F-16 a week later.

a. The U.S. Proposals

As previously mentioned, in the first meeting with the four nation steering group in late June, 1974, Deputy Secretary of Defense Clements conveyed to the four that the U.S. was willing to complete prototype source selection in January, instead of May, 1975, if they could postpone their decision until then.[4]

At the second meeting with the Steering Committee in mid-July, the U.S. made a number of additional commitments to the four governments:

- The commitment that "The USAF will make a source selection of the LWF by January 1, 1975;

- This aircraft, once fully qualified would enter the USAF tactical fighter inventory and would be deployed in Europe;

- The Air Force would establish a NATO liason office within the LWF Program Office, if any consortium member wished to participate in the program prior to source selection, they could assist in the preparation of RFP's and source selection;

- The U.S. delegation agreed to provide cost estimates, and;

- In response to the Europeans' emphasis on significant participation in production the DoD would negotiate a government-to-government agreement committing the U.S. to the following:

  (1) the four nations would produce 10% of the value of the USAF buy (with final assembly in the U.S.),
  (2) the four nations would produce 50% of the value of their own procurement with final assembly in Europe and,
  (3) the four would produce 10% of the value of 3rd country sales.[5]

Guarantee for these commitments created a very sticky problem. The U.S. sought to avoid the term 'guarantee' whenever addressing production shares, while the Europeans sought them, stressing that the lack thereof would create a major roadblock in their selection of the YF-16/YF-17.

Also of import in this agreement was the fact that, as stressed by Deputy Secretary of Defense Clements, this was the first time the U.S. government had intervened in an international sales competition on behalf of an American aircraft that had yet to enter full scale development. One of the major implica-

tions of this precedent was its dilution of the DSARC process. "While the DSARC principals were parties to the guarantees, these self-same commitments effectively made the DSARC's that were to follow pro forma."[67]

The four European governments submitted their counter-proposal for their industrial participation shares near the end of July, in which the 10-50-10 formula would be adjusted to a 10-40-20 plus a guarantee that the off-set level would be no less than 70% of the value of their aircraft purchase.[7]

In August, after consultation with the Program Office concerning the feasible range of compensation, the U.S. delegation met with the consortium in Brussels, Belgium, and offered to revise the prior 10-50-10 formula to 10-40-15. In addition, the U.S. made a commitment of 58% on the consortium's portion if it was 1,000 aircraft program, 80% if 1,500 aircraft and of 100% if 1,967 aircraft were eventually produced. Any offset production beyond the 100% level was to be a subject for further negotiations.[8] The U.S. delegation returned with the impression that their offer had been favorably received, as well as the consortium's agreement to postpone their September decision deadline to mid-January, 1975.

Leading the delegation, and chief U.S. negotiator from this point on, was the Assistant Secretary of the Air Force, Installations and Logistics, Frank Shrontz (soon to occupy the same position at the DoD level). Other members of the delegation included representatives from the Departments of State and Defense, USAF Headquarters and the Air Force Aeronautical Systems Division (ASD).

Fred Wood, the civil servant who served as the SPO's Business Manager, was to later refer to this U.S. team, plus his experiences in working post-MOU business problems, in citing, what in his view, were the two most significant lessons learned during the project.

- Keep the team of actors small and thereby avoid institutional petrification.

- Because of differing business/cultural moeures, one must be willing to meet the other participating nations half way.

On the latter point he cited his ability to speak French as having been helpful. On the first point, another member of the USAF negotiating team, Col. Ron Carlberg, pointed out several years later while discussing the program with several USAF and Boeing participants involved in putting together the NATO AWACS project, that, unlike the F-16 project with Frank Shrontz, the NATO AWACS project suffered during the proposal phase in that there was no one person ever really steering the project. Not only did Shrontz provide direction and continuity to the U.S. proposal effort, but as pointed out by Col. Carlberg, Shrontz was exceptional in that he came from the industry side (Boeing), and knew the importance of keeping industry in the loop. Shrontz made it a practice to have GD and Northrop in for meetings to clear industrial commitments prior to passing them on to the Europeans. This issue of coordination of U.S. Government-Industry positions prior to coordination at the government-to-government level has haunted the U.S. in virtually all its inter-allied projects.

Under the pressure of severe competition from the French and Swedes vis-a-vis the terms of industrial participation, further U.S. concessions were to follow in early 1975, following the U.S. selection of the General Dynamics YF-16 as the development vehicle for the new Air Combat Fighter (ACF). This pressure was to further increase as the consortium's January selection deadline began to slip through winter and well into the spring of 1975.

For the initial production run of an F-16 produced solely by U.S. industry, the unit flyaway cost was estimated at $4.6 million in FY 1975 dollars and the unit program cost (including spares, support and training equipment and data as well) was estimated at $6.7 million. The U.S. negotiators submitted a new proposal to the consortium in January, featuring for the first time a "most probable" average unit flyaway cost of $5.69 million 1975 dollars, and an estimated "not-to-exceed" price of $6.09 million in 1975 dollars. These figures included $670,000 (later reduced to $470 K) for recoupment of U.S. R&D costs along with the extra costs of establishing two new production lines—one in Belgium and one in the Netherlands. In addition to this unit fly away cost, it was judged that spares might add 20% to the unit price, and ground equipment another 15%. The 10-40-15 formula for industrial participation was maintained.

At this point, the consortium, after analyzing the various aircraft proposals, was most concerned over the threat of inflation and fluctuations in the exchange rates during the life of the program. The recent experience of the U.S. economy, in particular, was not reassuring on this score, and none of the proposals, including the French, was altogether clear. So the consortium

further postponed their decision pending a clarification of the three sets of proposals and, possibly, further concessions by the prospective sellers. The responses to the purchasing consortium's queries were not completed until March 17, and meanwhile further concessions were indeed forthcoming.

On February 26, 1975, Deputy Secretary of Defense Clements announced that the U.S. would allow the 15% production participation on third country sales to continue indefinitely after the 100% compensation level had been achieved.

In their clarifying submission in mid-March the U.S. negotiators offered a detailed analysis of price escalation and currency fluctuations as they related to the U.S. proposals. With regards to price, the U.S. analysis centered on an explanation of the assumptions upon which it had based its "not-to-exceed" price which included:

- the assumed purchase quantity, and;

- the applicable U.S. and European national indices to be used in computing escalation allowances.

On the currency issue, U.S. negotiators were constrained by the legal requirement that defense contracts be expressed in U.S. dollars. Congress would not even consider supporting a possible footing of the bill on a unilateral basis by the U.S. for any potential exchange rate losses. In any case, with the post-1973 international monetary system being based on floating exchange rates, it was expected that any fluctuations would tend to be counteracted by

differential rates of inflation over the long-run. Furthermore, since the production for the European purchased aircraft were divided approximately on a 40/60 basis between Europe and the U.S., the swings would be dampened. For example, any increase in the cost of the aircraft due to appreciation of the dollar would be partially offset by corresponding decreases in the European built portion of the system.

In its May 2, 1977 special issue on the project, Aviation Week & Space Technology printed an interview with Frank A. Shrontz, the former chief U.S. negotiator during the competition for the F-104G replacement in his capacity as Assistant Secretary of the Air Force Installation and Logistics (I&L) and later Assistant Secretary of Defense, I&L. (By the time of the interview Shrontz had returned to Boeing as its Corporate Vice President for Contracts. In this capacity he co-sponsored the initiation of this business history of NATO several months later.)

According to Shrontz the most difficult factor in selling the USAF's ACF in Europe was the need to assure the consortium members that the U.S. had credibility in weapons collaboration. The credibility of the U.S. had evidently been seriously undermined when anticipated offsets had failed to materialize after pior sales such as the Lockheed C-130, tanks, missiles, and radars. This time they were determined to pinn down the U.S. on its commitments.[9]

Another big job, Shrontz mentioned . . . ."was to establish in their minds that they would participate and not be subcontractors."[10]

On the other hand, the easiest point in the negotiations according to Shrontz was that the U.S. had the best product. Price, however, was another problem. It was tougher to sell, "but we aproached the program openly and candidly. We gave assurance that it was a good program under cost control and that we gave the competitors a fair evaluation." The U.S. was able to generate confidence among the consortium participants, during the following source selection. "We literally laid the whole book open to them," Shrontz said. This was a particularly sensitive point since "we have to pass on what the real costs are. The French appeared to guarantee a fixed price."

"General Dynamics could give a 'not-to-exceed' cost. The U.S. government could not guarantee a maximum cost."[11]

Politically, Shrontz said, "we worked pretty hard on the theme of NATO Standardization," since the U.S. would be basing several hundred F-16's in Europe.[12]

While the U.S. was negotiating with the consortium, "the French worked very hard on the concept of a European aerospace industry. They pressed the point that they had an aircraft in existence with a good track record. They guaranteed their price."[13]

Continuing on this point in the same Aviation Week & Space Technology article Blaine Scheideman, GD's Vice President and director of the F-16 Program, added, "The F-1 competitor was a credible aircraft but we felt it represented the end of a line of development, while the F-16 is the first of a new line.[14]

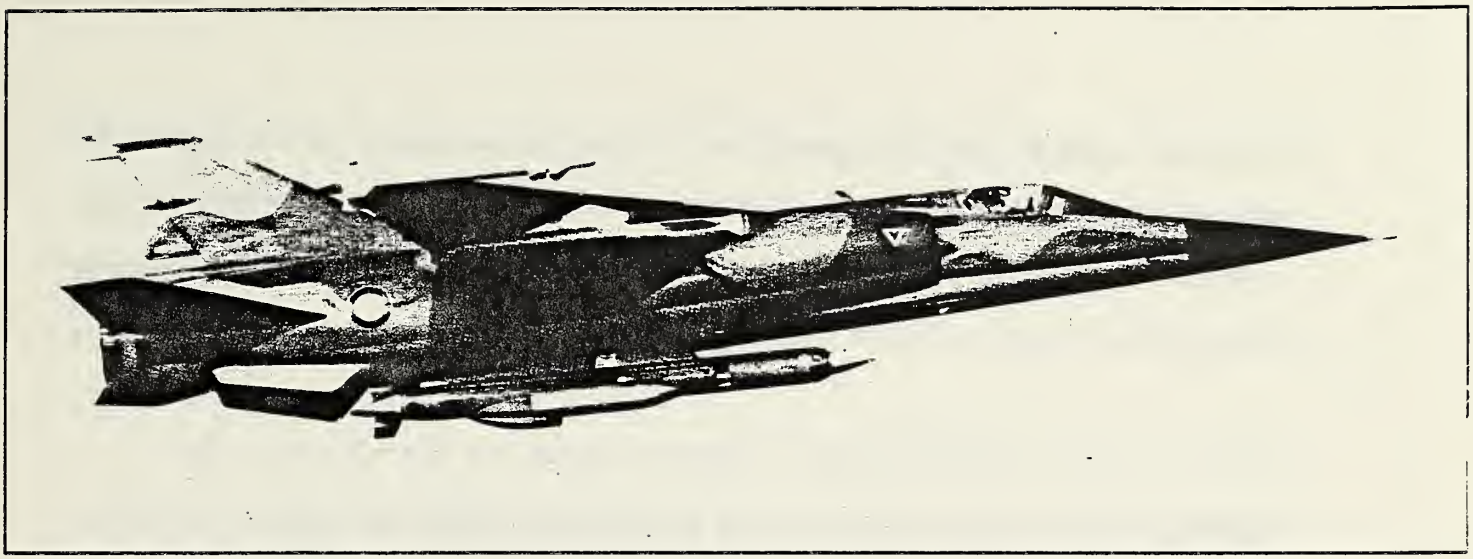
From the contractor's viewpoint, Scheideman continued, having ". . . . determined that the NATO countries wanted a U.S. aircraft only if the U.S. put it in its inventory, unlike the Northrop F-5 and F-104, ". . . our strategy was to win in the U.S. first, and then sell in Europe."[15]

Fred Wood, international business advisor in the USAF's F-16 SPO, believed that the prior U.S. procurement decision was the single most important contribution to the eventual European selection. "What swung the deal is that the Europeans didn't want to buy an aircraft from a supplier. They wanted government involvement. They wanted to be sure the U.S. had a vested interest and that they would co-produce a part of the U.S. machine.[16]

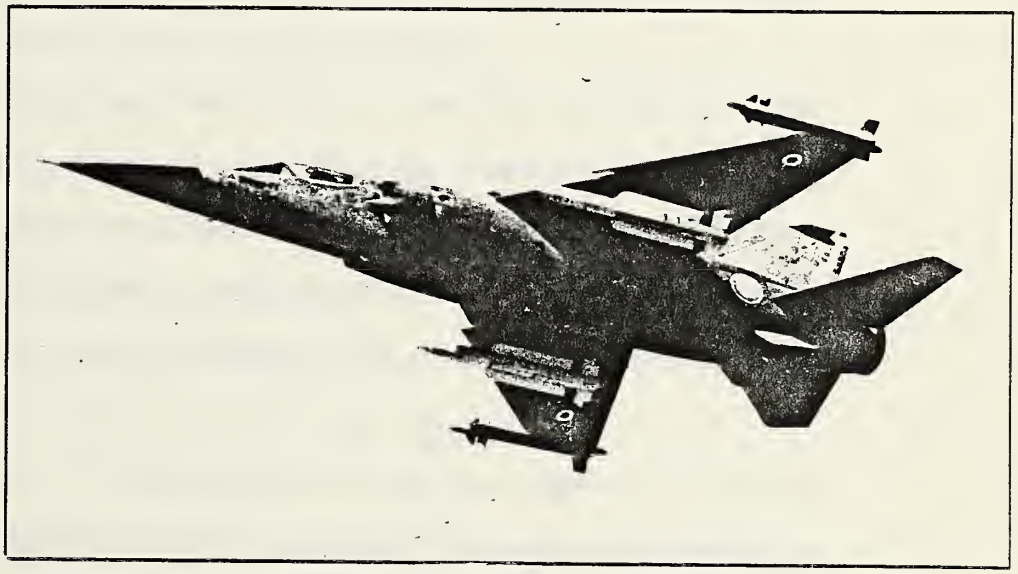
b. The French Proposals

For France the F-104G replacement competition involving Belgium, Denmark, the Netherlands, and Norway was the fifth in a series of 'NATO' multi-national fighter competitions. First, France's two finalists in the 1957 NATO Lightweight Strike Fighter (LWSR) prototype competition (one from Dassault and one from Breguet) lost out to the Italian Fiat G-91 in a controversial decision, after which there was somewhat of a backlash against NATO and the U.S. in France.[17]

Secondly, for the German multi-purpose fighter competition of the following year, 1958 (one which, after selection, expanded to involve three other NATO Nations, Belgium, the Netherlands, and Italy) the Lockheed F-104 beat out France's Dassault Mirage III. This was followed by screams of foul in France, and unfair U.S. government intervention.[18] The German Government had even



▲ This French Air Force *Mirage* F.1 is equipped with a *Caïman* offensive jammer under its fuselage, as well as a *Remora* self-protection jammer under the right wing. Also visible are the antennas on the vertical tail of the BF-series radar warning receiver. All three EW systems are from Thomson-CSF.





held up release of the final decision fearing the political repercussions that it would have in France. As de Gaulle had just returned to save the nation from collapse into civil war, the prestige of France, the de Gaulle government and the new republic (France's fifth) was on the line.

Thirdly, France's V/STOL Mirage II/Balzac design was a finalist in the January, 1962, impasse over the G-91 replacement NBMR3—an impasse that was never resolved and led to several unilateral national developments—NATO being further discredited in French eyes.[19]

Then, in 1968 Belgium and the Netherlands were planning to choose a common ground support fighter, operating as a consortium for both selection and production, but France was able to lure Belgium into breaking ranks and selecting the Mirage 5—leaving the Netherlands on its own to select the Northrop F-5 and produce it collaboratively with another NATO ally, Canada.[20]

So here the French were facing round number 5 in a series of competitions for a fighter order by a multi-national grouping of NATO member countries. Their contestant, the Dassault Mirage F-1 had already been selected by two NATO European nations—one in NATO at the time, Greece, the other closely aligned and eventually to join NATO, Spain.

Building up from a small initial order base of 40 aircraft provided by the Armee de l'Air, the Mirage F-1 got off to a promising start through export sales.

This Armee de l'Air order base gradually increased to 246 F-1's by the fall of 1980. Though the F-1 had originally been developed for export purposes, there being no Armee de l'Air requirement, it came to serve in an ever expanding gap-filler role as replacement schedules slipped for the Avion de Combat Futur (ACF), and then for the Mirage 2000.

One of the consortium countries, Belgium was actually already participating in the production of the Mirage F-1, through the firm SABCA (50% owned by Dassault-Breguet). This F-1 production role emanated from an external offset following the prior 1968 Belgium order for the Mirage 5.

The Mirage F-1 had entered service with the Armee de l'Air in early 1974, powered by an Atar 9K50 engine. For this competition Dassault was offering an advanced version of the F-1 powered by the new SNECMA M-53 engine. The F-1E was also serving as the M-53 flying test-bed. The first flight of this version designated the F-1E would not be until December, 1974.

In mid-1974, French government and industry initially proposed a rather vague offset package worth 100% of contract value; and absorption of prototype development and testing costs of F-1, non-recurring R&D cost for the SNECMA[21] M-53 engine, and 50% of airframe IR&D costs. The French government was prepared to guarantee that if any two or more of the countries adopted the F-1E version of the fighter, it would be adopted by the Armee de l'Air, as well.

For the second proposal, of September, 1974, France was forced to be more specific. This led to an off-set offer involving recoupment of 70% of the acquisition costs of the aircraft for this purchase alone, with higher per-

centages of 82% being possible if projected third country sales materialized. The purchasing countries would be expected to pay half of their pro rata share of F-1 development costs, but be guaranteed a firm fixed flyaway unit price equivalent to $5.5 million with France absorbing any inflation over 7%.

As selection once more slipped in January, 1975, France again revised its proposal. The French government was now prepared to increase its 40 aircraft order for the Armee de l'Air to 120 aircraft to match the largest single-country purchase, even if this meant delaying its own planned follow-on fighter program, the Avion de Combat Futur (ACF). In addition, the French froze the price at 27 million francs (equivalent to $6.4 million at that time) and offered a guarantee that any cost escalation due to inflation would be absorbed above specified levels: above 7.5% during the first three years; above 16.5% in the next three, and above 5.5% in the last three. This time around the French were again speaking of a 100% offset, claiming a larger expected sales of 1,000 aircraft, but also adding on work on a piece of the next generation ACF program if and when it went into production.

As the selection deadline continued to slip and the competitive pressures built up while awaiting the hour of decision in March, France submitted, along with the U.S. and Swedish governments, additional details requested by the consortium concerning inflationary and currency exchange loss guarantees. In addition, to these and other financial issues, rance restated and broadened its pitch with regard to its management, political, technical, and industrial aspects.

In addition to the inflation and currency issues the French proposal also was obliged to respond to the multi-national steering group's recent conclusion that the F-16 was significantly less costly than the proposals from Dassault and Saab-Scania.

The purchasing consortium considered the gap was too great between Dassault's price of 27 million francs unit fly away cost for the aircraft in its basic interceptor configuration and the real price of the fully equipped aircraft configured for its multimission requirements including the ground attack, long-range interdiction and fighter missions, estimated by them at the equivalent of $9.5 million.[22]

Dassault countered this assertion with the following set of arguments. First, they contended that the unit fly away cost for the F-1 was a firm, fixed price that could be guaranteed because of the limited technical risks involved. According to Dassault, the two aircraft were not comparable at the present time since the U.S. aircraft was only an experimental prototype still requiring development and debugging over a several year period. In contrast the Mirage F-1E was already a well proved aircraft offering the best compromise for the 4 countries' broad range of mission requirements and one that could offer an operational system in a very short period time. While down-playing the developmental nature of the SNECMA M53 engine, Dassault pointed out the major cost overruns on several U.S. programs, and particularly General Dynamic's F-111 experience, to support the argument.[23]

On exchange rates, the French stressed that their proposition involved only European currencies, which have a far greater stability among themselves than with respect to the U.S. dollar.[24]

Dassault further supported its price on the grounds of the guaranteed maximum inflation rates that it had offered back in January, and its offer to establish a multi-national technical management team. The team would provide for substantive participation in project management, and among other tasks, approve or reject proposed modification to the F-1E once a baseline technical and operational definition of the aircraft was established.[25]

The principal new price-related argument put forward by the French in this March round, was however, a new pricing formula for the F-1E that would theoretically lower the cost of the aircraft by about 23% and thereby put it at approximately the same price level as the competing F-16. The new formula involved:

- an 8% reduction in industry's costs (but Dassault's non-French suppliers had yet to agree to a reduction of their 36% of the aircraft);

- a 5% reduction through a French government contribution, and;

- an assumed rise in the value of the U.S. dollar by 10%.

On the political front, French thrusts continued to concentrate on the theme of European unity and cooperation, in both the aerospace field as well as other sectors such as computers, nuclear energy, and agriculture. In aero-

space French negotiators presented some vague proposals for total integration of the European aviation industry and even French acceptance of reintegration into the military side of the Alliance.[26]

The industrial collaboration package, in the French view, should be viewed as a significant step towards realization of the European aerospace industry. Unlike the U.S., France was offering a single source package for all F-1's produced after the multinational team is set up, with the only limit on offset being on the value of ultimate sales. This would naturally lower production tooling costs, because only one set would be required (existing tooling being transferred to the purchasing countries).[27] Despite this non-duplication of manufacturing, like the U.S. offer, the French proposed the attractive if somewhat wasteful characteristic of assembly lines in two of the consortium countries. (Unlike the earlier F-104G project though, the European assembly of the replacement fighter would involve Belgian and Dutch industry acting in the capacity of subcontractor, not as a licensee and thereby a prime contractor fully responsible for the end product.)

The guarantee of 70% offset on the consortium purchase on all sales up to 600, and then increasing in a straight line to 100% at 1,000 aircraft sold, still held. This time though the French were emphasizing the 140% that could be reached with sales of 1,500. For Belgium and the Netherlands, with larger aerospace industries than Denmark and Norway, the total offset could reach 200% at the 1,500 aircraft point.[28]

Citing all the above factors as evidence, Dassault represented its fully integrated sole-source effort as a true European co-production program. The U.S.

program, they pointed out, would only reduce their industries to the status of second source subcontractors subject to fluctuations in the American workload, which could result in all work eventually being drawn back to the U.S.[29]

The list of prime candidates for European industrial participation on the F-1E program very closely resembled the U.S. list. These were:

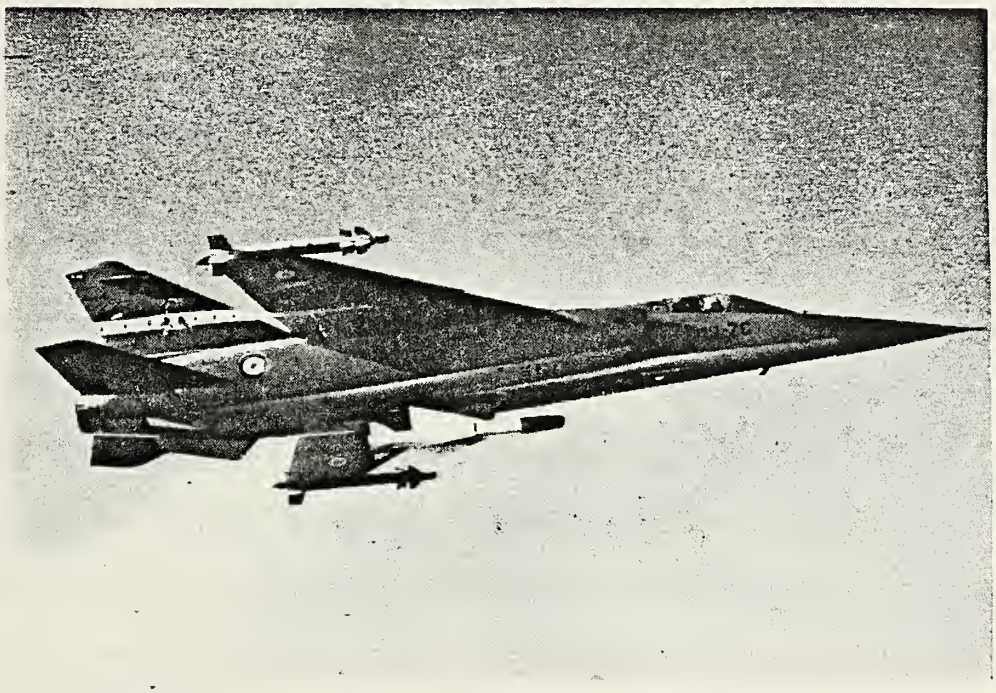
- Belgium—Fairey and SABCA, forward, mid- and aft fuselage sections, empennage and final assembly of aircraft for Belgium; Fabrique Nationale Herstal, components for Snecma M53 engine; Gebecoma, a grouping of Belgian aerospace equipment manufacturers, would provide much of the equipment for the F-1E.

- Netherlands—Fokker-VFW, mid-fuselage sections, fuselage fittings for all aircraft and final assembly of aircraft for the Netherlands; Philips' Gloeilampen-Fabrieken, components for Thomson-CSF radar and lead contractor in the Netherlands for electronics and avionics work on the F-1E; Optische Industrie de Oude Delft, heads up display work in conjunction with either Thomson-CSF or Marconi-Elliott; DAF (Van Doorne's Automobiel Fabrieken); hydraulics in conjunction with Messier-Hispano of France; Sun Electric, mechanical equipment.

- Denmark—Per Udsen, Terma Elektronik, Bravour Div. of AGA and Disa Elektronik, were to receive work for the electronics and avionics.



Saab Viggen.



- Norway—Kongsberg Vapenfabrikk would be lead contractor in Norway for avionics production. Engine work would also be placed with Norwegian firms (unspecified as of that time).

It is noteworthy that the French government and press seemed to place a greater value on the European consortium's order than the Armee de l'Air, or the French aerospace industry. The Armee de l'Air never expressed any desire to receive the F-1E despite the January commitment of the French Defense Minister to order at least as many aircraft as the largest single European buyer. The Armee de l'Air felt that the F-1E acquisition jeopardized, or at least delayed the development and procurement of its ACF for the 1980's. French industry as well was reportedly showing some reservations on the price it would have to pay in diverted development funding, lost work, and possibly sales for this major political achievement.[30]

The Armee de l'Air considered the F-1E not only costly but marginally better than the Mirage F-1's powered by the Atar 9K50 engines.[31] Ultimately no Mirage F-1E's were ever produced, the M-53 powering only the Mirage 2000 in the end.

c. The Swedish Proposals

The Saab-Scania 37E Eurofighter, variant of the Viggen, competing for the NATO F-104G replacement, was to be a hybrid of the original attack version of the Viggen, the AJ37 (in squadron service with the Swedish Air Force since mid-1973), and the JA 37, an all-weather fighter version of the Viggen (entry into service being scheduled for 1978). The JA37 Viggen was the fifth version of this Mach 2 combat aircraft to be developed.[32]

In the early 70's Swedish export policy toward military aircraft underwent a drastic change, slackening its previous restrictive policy of selling only to 'non-aligned' nations, so as to be able to offset the vertiginous rise in the cost of new development programs by exports. It was expected that the Swedish Air Force would ultimately receive some 400-450 Viggens in its various versions. which is little more than half of the 750-800 planned when the program was launched in the mid-60's. The 4 country consortium's order of 348 aircraft would have helped to counter-balance this problem. However, at the time most observers of the competition gave Sweden only an outside chance of winning the contract. This was a judgement predicated primarily on political considerations, Sweden being both a non-NATO and non-EEC country. Sweden's main hope was to be able to counter these considerations by a very generous internal and external offset package, the multi-role aircraft's technical qualities, and a possible break up of the consortium.[33]

On this latter possibility, the Saab-Scania proposals of April, 1974, were originally aimed individually at Belgium[34] and the Netherlands, dismissing the possibility of the consortium holding together. Saab-Scania considered these two consortium members as the only two that could allocate funds at this stage, and offered each a seperate offset package. In contrast to the early French and U.S. offers, the Swedish one was not originally based on an integrated effort. The Swedes figured Norway and Denmark could only declare a possible interest, not being in the position to make a firm commitment until 1977-79.

The Swedes showed that they were willing to go to extreme lengths in catering to consortium sensibilities regarding its non-NATO status (of major relevance

in time of conflict), and in supplementing aerospace offsets with other non-aerospace work. In order to ensure complete program independence the Viggen would be produced completely within NATO countries. The airframe, engine and major avionics components were to be managed and produced mainly by industries in the purchasing countries, but with the U.K., the U.S., and the FRG also receiving some work, as they were already suppliers of certain sub-systems.

Based on a 100 aircraft order by both Belgium and the Netherlands, Sweden was offering each aerospace industry work totaling approximately 20,000 man years or 60% of the aircrafts' purchase price. This would also involve immediate industrial participation in the development work for the Eurofighter version of the Viggen. The fact that 40% of the equipments in the Swedish aircraft were of foreign origin, naturally tended to complicate the task of distributing this compensatory work.[35]

For Belgium the aerospace work would involve building a major portion of the airframe plus final assembly of the Belgium aircraft at SABCA and Fairey.[36] For the Viggen's RM8B engine, Fabrique Nationale had signed an agreement which would allow it to produce the majority of the engine parts and assemble the complete engine. For offset work external to the Viggen, the setting up of a new Volvo facility in Belgium as well as considerably increased production from existing plants in the automotive and electronics fields was offered.[37]

Production of the electronic, hydraulic and mechanical equipment, both of Swedish and foreign origin, would be shared between Belgian and Dutch industry.

If the Netherlands selected the Viggen, Fokker would assemble the Dutch aircraft and have a major share in manufacture of the airframe.[38]

By late summer 1974, the Swedish offset package had been restructured so as to deal with a firmed up commitment by the Danish and Norwegians to participate in the multi-national program. In order to counter balance the lesser prospects for third country sales, that the Viggen offered, the Swedes also came to rely very heavily on external offset. At this stage the Swedes were offering the Netherlands 160% of the value of their purchase in offset orders, the Belgians 200%, the Norwegians 120%, and the Danes 100%.

In early 1975, Sweden again raised the ante with additional compensatory inducements to consortium industries including an increase of the Danish offset to 150%. In addition Swedish aircraft, automotive, and electronics firms (Saab, Volvo, and Ericsson) would finance a ten-year, billion dollar program of industrial development in the four countries.

As far as the participation in the production of the aircraft is concerned, the table below shows the percentage of work breakdown within NATO by country:

	Airframe	Engine	Avionics
Belgium	34	41	33
Denmark	8	5	13
Netherlands	33	8	29
Norway	--	25	14
Others	25	21	11

The list of participating companies in such proposed offsets includes: Airframe—Fokker-VFW, SABCA, Fairey, VFW-Fokker, Per Udsen; Avionics—Hollandse Signaal, Philips, Sybelec Group (MBLE, etc), Siemens, Bruel & Kjaer, Terma,

Kongsberg, Nera; Engine—Fabrique Nationale, VMF, Hollandse Signaal, DAF, Duiker Apparaten Fabrik, Philips, Artillerie Inrichtingen, Enraf-Nonius, MTU, Nordentoft, Bola, Disa, Kongsberg. For equipment, companies from...the four consortium countries plus British, U.S., and German firms. Belgian and Dutch firms were also being guaranteed al least a 50% share of production work on any third country sales of the Viggen.[39]

There was also external non-aerospace work, (also referred to as parallel or indirect offsets).

In March, 1975 the Swedes, French, and American offered what were to be their final proposals. In this final round the Swedes again substantially increased the external industrial offsets. The industrial program guaranteed by Saab-Scania, Volvo, and L. M. Ericsson in addition to the direct industrial participation would amount to $980 million in work to the Netherlands and $1.62 billion to the Belgians (the significant difference stemming from Belgium's greater industrial capabilities). Saab claimed that the income to the two states generated by this program and the avoided unemployment would be equivalent to a net cost reduction of $470 million to the Dutch government and $800 million to the Belgian government, or a reduction in the price of their aircraft of 48%, and 73% respectively. To both Denmark and Norway the similar case was made, but one involving smaller numbers due to their industries offering less in the way of possibilities.[40]

Earlier in the same month, March, the Swedish government had refused to provide firm guarantees to the consortium against unfavorable inflation and currency exchange rates. and instead Saab-Scania revised its original proposals

to the four to incorporate a total package price reduction of between 8 and 9% primarily through simplification of the equipment package.[41]

In addition Saab-Scania countered with the argument that the escalation of income generated by the contracts would almost entirely offset the impact of inflation on the aircraft purchase contract in Belgium and the Netherlands, due to the large aerospace and non-aerospace industrial offset programs. Fluctuations in currency exchange rates would not affect expenditures to any great extent either, since 80% of the price of the aircraft would be paid in native currencies.[42]

Saab-Scania also claimed that though its purchase price would be higher, lower operating costs than either competitor would involve a saving of between $700,000 to $1.25 million per aircraft over 15 years of service life.

So as to counter concerns of Sweden not being a NATO member, the Swedish government had issued a letter the previous December to the 4 consortium countries, guaranteeing delivery of Viggen components. In March, a further arrangement was proposed under which special spares stockpiles would be established in client countries to eliminate the possibility of interruption in deliveries of spares and components.[43]

4. MOU and Project Management

As of May 1975 the USAF had commited itself to fulfilling the DoD's offer to the government consortium, if the F-16 was selected. The four European countries ultimately committed themselves one by one between May 30, and June 10, 1975 when the selection announcement was followed by their signing of the Memorandum of Understanding.

Over the period from late fall 1974 until ultimate execution by the Secretary of Defense for the U.S. on 10 June, 1975, the MOU had become the principal working document laying out the fundamentals of the multinational program. Critical among these were the terms of the European industrial participation negotiated under the duress of competition with the French and Swedes, covered in the previous section. The signing of the MOU was then to be followed by the signing of 4 individual Letters of Offer and Acceptance (LOA's) along the lines of standard FMS procedures for a government-to-government sale.

Chief U.S. Negotiator, Frank Shrontz, had relied on a nucleas of 10-12 experts from the DoD - representing legal, technical and security - to provide continuity and balance during these negotiations. A draft version of the MOU was drawn up by the SPO and had been provided informally to the Europeans to serve as a departure point. In the words of Shrontz:

> We had a half-dozen negotiating sessions here and in Europe. We tried to raise issues and answer them over and over. We came up with a Memorandum of Understanding that all five could sign as a preliminary contract.[44]

The MOU thus came to serve as the basic charter for the F-16 program. Constituting a de facto contract, the MOU committed the U.S. Government to the following:

- Procurement of a minimum of 650 F-16 aircraft, of which a substantial number would be stationed in Europe.

- Providing EPG industrial participation in F-16 production to offset EPG procurement costs. Production and assembly contracts are to equal at a minimum 58% of the procurement value of the 348 EPG aircraft purchase costs, with additional offsets to come from third country sales and possibly further USAF and EPG orders. (While the term procurement value was defined, the terms used in the definition were not settled, leading to future problems.) Assuming "reasonably competitive" prices (another term which is not well defined in the MOU), the DoD agreed to direct the F-16 prime contractors to place with EPG industry:

  - 10% of the procurement value of USAF F-16 aircraft, totaling originally 650 aircraft;

  - 40% of the procurement value of all EPG F-16 aircraft;

  - 15% of the procurement value of all third country F-16 aircraft;

- Management of the Multinational Fighter F-16 program.

- An estimated not-to-exceed price of $6.091m (FY 75 $) for the EPG aircraft.

- Utilizing depot maintenance and overhaul facilities established and funded by EPG (and industries in those countries) on a mutually agreed basis for USAF F-16 aircraft operated in Europe.[45]

The complete MOU was constituted by the following sections:

Section A The Cooperative Program

Section B The Steering Committee

Section C The Program Charges and Payments

Section D The Production Program

Section E Contracting

Section F Technical and User Rights

Section G Security

Section H Third Country Sales

Section I Accession of Additional Governments

Section J Taxes and Duty-Free Entry

Section K Release of Information to the Public

Section L Industrial Participation

Section M Contract Administration Services

Section N Test Facilities

Section O Configuration Management

Section P Termination

Section Q Reduction

Section R Non-recurring Cost

Section S Further Cooperation and Implementation

Section T Language

Section U Effective Date

Annex A. Reasonable Competitiveness.

Supplement No. 1. Shifting of fixed rates of exchange as of January 13, 1975 to June 6, 1975.[46]

Upon selection of their common fighter, the four-nation steering committee that had originally been formed to evaluate the various candidates, evolved

into a five-nation committee including U.S. representation. This expanded Steering Committee, established by the MOU is the chief advisory body for the program, insuring that the terms of the MOU were met. Primary among these was approving co-production manufacturing plans in compliance with terms of the MOU, vis-a-vis offset. The Steering Committee's other tasks were approval of arrangements covering: cost sharing for configuration changes and contractual services; currency management; and the development of a coordinated operational and logistics support plan encompassing the F-16's of all five air forces.

It is important to point out, however that, unlike the normal 'NATO' Steering Committee, the F-16 Steering Committee is not responsible for direction of the program. Direction comes down from the U.S. DoD to the ASD and the SPO. As of spring 1977 the Multinational Steering Committee was headed by the Assistant Secretary of the Air Force (I&L) and included the five national representatives:

- A USAF Major General, director of development and engineering in the office of the deputy chief of staff for research and development;
- A Belgian Major General;
- A Dutch Major General;
- A high level civil servant from Norway, and;
- A Danish Rear Admiral.

The committee meets at least quarterly.

Its major subcommittees[47] are:

- contractual and financial;
- industrial;
- operations, and;
- logistics.[48]

The USAF SPO actually manages the program, receiving direction from the DoD and advice from the Multinational Steering Committee. As mentioned above, unlike the standard NATO Steering Committee - national program office relationship, policy guidance and overall direction do not rest with the F-16 project's Multinational Steering Committee.

From the SPO's initial manning level of September 1971—17 with one colocated engineer—it had reached 302 by early 1977. This growth represented an evolution of the SPO from a small program office whose role was simply to monitor the contractors technical, cost and schedule performance by drawing on functional specialists as needed, to one whose greatly increased importance, dollar value, and complexity required a tightening of the management reins. On this point General James Abrahamson, F-16 program manager had this to say in an interview published in the May 2, 1977 issue of Aviation Week & Space Technology:

> This is by far the most complex program in the Defense Department, probably the most complex in history. It is a management nightmare. It would be the biggest single mistake to keep the SPO too small.[49]

Of this level of 302 military and civilian employees (reaching 350 by early 1978), 48 were dedicated to consortium and other FMS activities. These 48 positions were paid for by the 2% FMS administrative surcharge in the LOA's.

The European Participating Government (EPG) personnel attached to the SPO at Wright-Patterson Air Force Base, Dayton, Ohio, numbered around 20 as of mid-1979 and operated as if they were USAF personnel.

Due to the F-16's Pratt & Whitney F100 engine having been initially developed for the F-15, the engine was managed by the Joint Engine Project within the F-15 Program Office (ASD) up to October, 1977. After October F100 management was shifted to the Propulsion Systems Program Office, the office which will ultimately manage all USAF engine procurement.

Contracting with the two SPO's are the two Primes, General Dynamics for the airframe and Pratt & Whitney for the engine. The total system performance responsibility clause in GD's contract, while modified with regards to the F-100 engine, commits the contractor to manage the total subcontract effort including final assembly and flight test in Europe through the following language...

> The contractor hereby accepts total System Performance Responsibility for the Air Combat Fighter System whether or not such Systems (or subsystems and components thereof) are fabricated, manufactured or assembled in the Consortium Country.[50]

Ordinarily surveillance of the prime contractors management of its subcontractors is carried out by the cognizant government contract administration

(AFPRO) office located at the prime contractor's facility. However, with a major part of the subcontract effort taking place in the 4 EPG's, program complexities and U.S. government responsibilities were such that special measures had to be worked out covering the division of those responsibilities to be delegated to the 4 EPG as well as those shared between the Air Force Systems Command (AFSC) and the Air Force Logistics Command (AFLC). This required the negotiating of Technical Agreement No. 1 to the MOU between the U.S. government and the 4 EPG's, and a working out of a memorandum of agreement between the AFSC and AFLC, both of which will be treated shortly.

5. Waiver of U.S. Government Perogatives and Negotiation of the LOA's

With the general nature of the intergovernmental, contractual and industrial framework having been agreed to in the MOU negotiations between the U.S. and the European governmental consortium, then came the task of working out the specific details of implementing the multi-national program.

For starters, in order to be responsive to the needs of the four European allies, the Air Force had structured, negotiated and awarded the F-16 contracts in a compressed time frame. In addition to this, the airframe contract had been awarded by the USAF to GD some five months prior to the signature of a finalized MOU (and one that left a number of issues either unaddressed or unsettled).

The U.S. signing of the MOU was accompanied by the signing of four preliminary bi-lateral contracts executed by each of the EPG's with the US government. These were to be replaced by conventional Letters of Offer and Acceptance (LOA's) within a 90 day period. Nearly 18 months passed, however, before the draft LOA's were completed and a total of 23 months before they were actually signed.

Given the interrelationship of these three sets of documents, the unavailability of adequate time, the lack of a logical sequencing of events, gaps in the MOU, and more generally the lack of the relevant prior experience that would have allowed the framers of the program to foresee and deal effectively with many of the problems, it is not surprising that there was a certain amount of program disruption and delay.

Among the large number of outstanding issues responsible for the 18 month delay in signing the LOA's, most centered around the extensive negotiation required for the ironing out of payment schedule for the aircraft and business differences between the U.S. and Europe. The resolution of most of these problems simply took time, as problems were surfaced and dealt with individually until they were resolved.

The government-to-government negotiations over payment schedules, and finance generally, will be covered later in section 9. Even though the program operated within the general US defense contracting framework, the USAF Program Manager, General James A. Abrahamson, made the following observation with regards to the impact of its being a multi-national venture on the manner in which program agreements and contracts have been negotiated and implemented.

> In all aspects where differences have been encountered the governments and/or the contractors have been required to negotiate a solution. The US cannot impose its procedures or standards on European industry. The result is normally a compromise in which both sides must alter their normal approach or treatment to some degree.[51]

Multinational agreements had to be negotiated concerning the application of the Armed Services Procurement Regulations (ASPR),[52] Cost Accounting Standards (CAS), quality assurance standards, configuration management, contractual and technical audit procedures, exemption of taxes and duties, termination, liability for patent infringements, liability for ground/flight damage, currency exchange and price escalation, progress payments to contractors, and a multitude of other F-16 program aspects of multinational concern. This naturally also involved a considerable amount of inter-agency/branch negotiation within the individual national governments such as U.S. congressional waiver of the specialty metals clause. Needless to say, all this had a major impact on industrial efforts to get production set up in Europe. In the words of Program Manager, General Abrahamson:

> Terms and conditions of contracts between the USAF and US industry must be passed on to European industry. Negotiation of these terms and conditions was accomplished, but with considerable difficulty. In many instances these negotiations were successfully completed only after reaching agreement at the Government-to-Government level on general principles of policy.[53]

The approach worked out was one whereby standard U.S. Government contract language, terms and conditions were used with specific Armed Services Procurement Regulations being exempted from flowdown provisions to foreign manufacturers, where appropriate. In some cases this required legislative relief, in other cases it was accomplished by blanket Secretarial waiver to the Armed Service Procurement Regulations. In the words of chief U.S. negotiator, Assistant Secretary of Defense Frank Shrontz:

> There were more problems than we anticipated. We learned that we have to look at compromises in working with the Europeans and not force them to accept our armed services procurement regulations. They made more compromises because we are bound by statute. They are more flexible. We must have arrangements on duties and plant cognizance. We can't expect them to blindly follow our practices. We should have been more realistic in our timing.[54]

The exercise by the U.S. Government of its perogatives in the areas of Cost Accounting Standards (CAS), audits, and specialty metals constituted particularly difficult problems for governmental managers. Faced with strong European resistance to the routine flow-down of ASPR clauses from GD and Pratt & Whitney to the EPG subcontractors, U.S. negotiators opted to make four controversial clauses non-applicable to the Europeans in the GD contract:

Examination of Records by the Comptroller General; Audit by the Department of Defense; Cost Accounting Standards (CAS); and, Preference for Domestic

Specialty Metals (Major Programs). The Pratt & Whitney contract made non-applicable all but the Cost Accounting Standards Clause.[55]

Following unsuccessful attempts by Air Force negotiators to obtain waivers from GAO and CAS Board, these two authorities discovered in August, 1975 that the clauses had already been unilaterally waived. On 11 August, 1975, in his dual role, the Comptroller General of the United States and Chairman of the Cost Accounting Standard Board objected in strongly worded letters to the Secretary of Defense.[56]

The letters had the desired affect and the requirement to flowdown the clauses was reinstated in both contracts. The European consortium nations, however, would not agree to accept these contractual provisions without modification.[57]

A meeting of the newly formed Multi-national Fighter Steering Committee was called for 23 September, 1975 to address the issue. The U.S. negotiators offered a draft proposal which would permit joint audit by the GAO, the Defense Contract Audit Agency (DCAA) and the official audit agency of the country in question. The Europeans objected, insisting that the sole right to audit should reside with their seperate audit agencies. A stalemate prevailed until January, 1976. The final resolution, Technical Agreement No. 1, was signed in March, 1976. Key elements of the agreement are:

1. GAO and DCAA will exercise their audit rights for subcontracts placed in the four EPG countries through their official EPG counterpart.

2. GAO and DCAA are entitled to designate "audit representatives" to accompany the EPG auditors doing the work. Similar rights are provided the EPG auditors with regard to GAO and DCAA audits of U.S. firms.
3. Under "exceptional circumstances", DCAA and/or GAO may decide to audit directly. The decision to do so can only be made by Senior U.S. DCAA or GAO officials; this decision may then be appealed by the Head of the EPG audit agency to the Director, DCAA or Comptroller General, as appropriate, who will make the final decision.
4. The EPG audit agencies will develop audit programs, procedures and standards which reflect U.S. audit agencies interests and concerns.
5. European audit reports will not be disclosed to "third parties" without country and sub-contractor approval.[58]

Agreement on the Cost Accounting Standards was less difficult. At a November, 1975 meeting of the Price and Audit Sub-committee, with representatives of the CAS Board and EPG companies present, all parties agreed on the wording of a memorandum. The governments and industries of the five countries agreed to accept application of the CAS Standards then in effect (CAS 401-407).

Additional Standards have since been enacted, however, and these new standards (CAS 408-415) automatically become a part of any new order placed under the G.D. and Pratt & Whitney prime contracts. The EPGs refused to accept application of the new CAS provisions to industries in their country and, in fact, attempted to reopen the subject of CAS 401-407. The DoD was caught between the EPGs saying their sovereignty was being violated by imposition of U.S. law on their businesses, and the GAO and CAS Boards who are reluctant to waive

their rights to examination of contractor records and right to audit where U.S. appropriated funds are involved.[59]

The U.S. Code requires that certain specialty metals be procured in the U.S. for those weapon systems purchased with appropriate funds. Under the MOU, any European subcontractor purchase directed to be made in the U.S. does not count as part of the offset. Consequently, applying this clause has a negative impact on the contractors ability to meet their offset commitment; as well as the ability of the U.S. Government to satisfy its own commitment. Ironically, the EPG producers would often have had to buy the material in the U.S. in any event since the only source available was in the U.S. (For the NATO Seasparrow project dating from several years earlier, the U.S. had been able to adroitly side step this issue and its impact upon creditability at lower tiers in a project involving the same four European countries plus Italy.)

> The Air Force hadn't many options. Getting the law changed would take too long, as would obtaining a waiver. The short term solution arrived at was direct citing EPG funds thus avoiding the use of U.S. appropriated funds. Specialty metals required by the EPG subcontractors were purchased citing monies held in this direct cite trust fund. The long term solution was a waiver of the specialty metals provision which was contained in the FY-78 Appropriation Act and made applicable to all programs which support NATO standardization.[60]

The basic problems associated with audit, examination of records and CAS are essentially the same. The DSMC study had the following statement on this subject:

> The EPG's took exception to all three requirements based on the proposition that since this was to be a cooperative arrangement the USG should not impose its laws, or requirements, upon the participating industries of the other countries. They feel, that; the clauses duplicate functions already existing in their countries, they should not be subjected to the scrutiny of U.S. agencies, that accounting systems would have to be duplicated, and that we would be usurping their national prerogatives. These remain sensitive issues with the EPGs.[61]

The dilemna was such that, if G.D. attempted to flow down the provisions to European subs, they could simply refuse to participate, while G.D. had already committed to its make or buy plan. Negotiations between the USG and EPGs, with the Comptroller General playing a significant supporting role, resulted in the forementioned F-16 Technical Agreement No. 1 which laid out a compromise position that all parties could agree to. The philosophy of flow-down, however, was never accepted by the EPGs. They have rejected application of cost accounting standards published at a later date and continue to raise the issue of forcing U.S. requirements on contractors of another nation.[62]

Waiver through appropriate channels on a case by case basis is a logical alternative but the process is time consuming and, since agencies outside DOD are involved, the probability of success is always questionable. Legislative relief for programs involving cooperative effort between the U.S. and our NATO allies is another possibility. It has the advantages of resolving the issue on a permanent basis and gives the contracting officer firm criteria under which to structure his contract. However, as stated in the DSMC study:

> We should approach this area with caution, since waivers of these controls do not relieve the Program Office and the Contracting Officer of assuring that public funds are spent properly. We may not desire blanket waiver for NATO. This may leave the Program Office in an untenable position since controls differ from country to country and in some cases may not be adequate to assure the Program Offices that prices from European subcontractors are fair and reasonable or that funds expenditures match the level of work progress. While legislative relief appears to be the most effective way to satisfy our European partners and solve our MOU problems it creates a dangerous environment for the Program Office.[63]
>
> Another alternative is to negotiate a compromise position as was done on the F-16 and it appears that, while this requires the most effort and time, it may be the most desirable course of action for all concerned. Moreover, if negotiating a compromise position is the course of action selected, the contract should not be negotiated until the details of such an agreement are finalized.[64]

The preliminary contracts between the four EPG's and USG were signed on June 10, 1975. These allowed the USAF to proceed immediately with the activation of the European Contractor Operation, including duplicate production tooling, long lead items and other administrative costs. The terms of the preliminary contracts were that within 90 days the U.S. government would present the Letters of Offer and Acceptance (LOA), and the EPG's would sign within 60 days of receipt. These preliminary contracts included only average "flyaway" costs for 348 EPG aircraft at the Not-to-Exceed value of $6.091 million (FY 1975 $).

As things turned out, the Draft LOA's were not completed until November, 1976, and signed the following month, some 18 months after the signing of the MOU and the preliminary contracts. The principal difference of a substantive nature between the preliminary contracts and the LOA's, and one that three of the EPG's found disturbing, were the budget and funding problems caused by unexpected increases in funds called for early in the program by the LOA's.

6. MOU Work-Sharing Definition Problem

Faced with the competitive offers of the French and Swedes, with regards to fixed prices and high guaranteed offset commitments, the U.S. negotiators of the MOU found themselves in a difficult situation. The U.S. government could not legally guarantee a maximum cost. But since the MOU took on the character of a contract, it's provisions as such, would be considered binding on the signatory governments.

However, despite the compression of the transition period which effectively mandated gaps in program definition, the F-16 SPO did have a relatively good cost-projection baseline at the time the four EPG's joined the program.

In negotiating the wording of the section of the MOU covering price, the EPG's insisted on binding terminology, while the U.S. negotiators had to resist making specific commitments on cost since this remained uncertain, being estimates only. Ultimately, the compromise language agreed upon was a not-to-exceed (NTE) price, that included all elements except for the radar, and GFAE. Additionally, Section O of the MOU covered arrangements for configuration management that would provide significant leverage in controlling cost growth. Any program changes impacting on the NTE price would have to be negotiated and approved unanamimously, or funded solely by the nation(s) requiring it.[69]

The U.S. negotiators also resisted placing a guarantee on the offset figures. The U.S. finally agreed to make a 'commitment', a word that was viewed by the EPG's as a promise, but by the U.S. government as "best efforts to meet a goal".[70]

First of all, the percentages of the offset formula were carefully considered estimates of what could realistically be expected from the EPG manufacturing community based upon contractor projections in their make or buy plans. Nevertheless, they were estimates which had no historical precedent to lean on as a basis for extrapolation. The only caveat associated with this offset commitment was the proviso that EPG manufacturers had to offer "reasonably competitive" terms. The term reasonably competitive has not been defined in finite terms. It was originally left to the Prime Contractor to determine whether or not a bid was "reasonably competitive." Had the normal ASPR provisions of price reasonableness been applied, the European co-production or offset would have been almost nonexistent. The conscious U.S. decision not to better define "reasonably competitive" early in the program in order to provide flexibility in meeting its offset commitments led to a dilemma, since the EPG viewed the NTE price as sacrosanct but insisted upon the USG meeting co-production and offset commitments.[72]

With the term "reasonably competitive" not concisely defined, GD, found itself being required to pay substantial premiums for certain items in their effort to meet the 10/40/15 offset formula, and therefore caught between a fixed price and higher costs. In paying these premiums GD, with U.S. government concurrence, pushed the fly-away cost dangerously close to NTE price for the aircraft.[73]

Eventually, GD reached the point where it would have had to push the cost over the NTE price were it to pay the premium required to close the final gap.

To further complicate the matter, there were several points of ambiguity in the computing of the unit procurement value and therefore the amount of offset required. First of all, based on the 10/40/15 formula, the U.S. agreed in the MOU to a minimum of 58% of the value of the four EPG's F-16 aircraft procurement. This figure of 58% was derived as follows:

Let X = Unit procurement value; then

USAF aircraft contribution = 10% · 650X = 65 X

EPG aircraft contribution = 40% · 348X = $\underline{140X}$[74]

Total 205X

and with the total procurement equaling 348 aircraft, or 348X

the total offset percentage = $\frac{205X}{348X}$ = 58%

But this calculation is deficient in that it assumes equivalent costs for USAF(X_1) and EPG(X_2) aircraft. Even with a standard configuration for these five NATO Air Forces F-16's, with four times (40:10) as much of the EPG aircraft being produced on a second source basis in Europe in comparison to the USAF aircraft, the EPG aircraft would naturally be more expensive.[75]

This differentiation of X, applied to 3rd country sales as well, where 15% of each aircraft was to be of EPG content.

> USAF negotiators recognized the fact that this was an approximation and that it reflected a higher guarantee than if a more accurate figure were used. However, the magnitude of the X could not be determined at the time of negotiations and both Northrop and General Dynamics had expressed a high degree of confidence that they could achieve roughly a 67% offset percentage with no problem. Further, we did not survey European industry ourselves to determine their capabilities but relied totally on the contractor's make or buy

> plans. The EPG made a strong pitch to secure a 100% offset commitment and pointed to the French offer in order to solidify their case. In view of these facts the 58% approximation and subsequent commitment are understandable.[76]

In addition to this X_1, X_2, and X_3 differentiation based on the cost impact of the three different percentages of second source European content, there was also a problem in defining what items were to be included in the procurement value, 'X'. The MOU stipulated procurement value to mean the dollar value of aircraft fly-away cost, plus initial spares, AGE, data, training equipment, and the pro-rata charge for non-recurring cost.[77] A problem arose, however, in that these terms used to define procurement value in the MOU, were not themselves defined.

National concepts of what constitutes initial spares levels, required AGE, data and training equipment varies substantially from country to country. The June, 1978 DSMC F-16 study stated that:

> We have not yet reached agreement on any of these values and as a result we have a floating baseline on which to compute procurement value and the change in required offset is significant. Until we set these figures the actual magnitude of our offset commitment or shortfall will not be known.[78]

In addition, the term "third-country sales" itself needed to be better defined. For several years following the signing of the MOU there was disagreement over two points of interpretation that had to be dealt with by the Steering Committee.

One, did the 15% of third-country sales mean all such sales in the strict sense or just 15% of that amount of such sales left to U.S. industry after a

certain amount of the aircraft had been produced in the third country. The latter interpretation eventually prevailed. The second point concerned whether and under what conditions the Europeans would have the right to produce 15% of third-country sales once total offsets had reached 100% of the original purchase value of the aircraft.

All the ambiguity not only clouded the government-to government commitments in implementing the MOU, but also complicated the issue of contractor responsibilities vis-a-vis offset.

As previously stated, the contract between the USAF and GD which was signed in early 1975 antedated the signing of the MOU between the governments by several months. Section J, Provision 1 of the contract stated that GD "would...enter into contractual arrangements with consortium manufacturers acceptable to and approved by the U.S. government and the Consortium, which will permit the establishment of the capability to fabricate and/or assemble aircraft, subsystems, or components called for under this contract in an amount equivalent to the..." 10/40/15 formula. The provision, however, did not mention the 58% offset since the earlier versions of the MOU then extant did not commit the U.S. government to the 58%. Quoting the DSMC F-16 study, "On the surface, it would appear that we could hold the contractor responsible for meeting the 10/40 and 15% commitments, however, several factors enter into the issue of enforceability."

> If we insist upon GD meeting the provisions of Section J, Provision 1 of the contract we would first have to settle the issue of which procurement value applies as "contract procurement value." Settling that question could be a very difficult task if our position was different from that of GD. Assuming we could settle the issue of which procurement value to use, we would have to determine if GD had met the percentages they signed up for in the contract. Then, if

they had not, we could attempt to force GD, possibly through withholding of progress payments, to meet the percentages called for in the contract. The problem then would be staying within the NTE price. Many of those familiar with the F-16 program feel that we could meet the commitments for co-production and offset but that the cost would raise the price to the U.S. and exceed the flyaway cost NTE. The provision is, therefore, for all intents and purposes not enforceable in our contract with GD.

In summary, several factors led to our current position concerning offset and co-production as they apply to the contract.

(1) While the term procurement value was defined, the terms that made up the definition were not precisely defined leading to a shifting base on which to figure co-production percentages.

(2) Reasonable competitiveness was not precisely defined and no direct relationship between reasonable competitiveness, Not-to-Exceed prices, and co-production or offset percentages was established in the MOU. If a relationship had been included which tied co-production commitment to reasonably competitive prices or a flexible NTE based upon how much extra the EPGs were willing to pay for co-production our relationships with the EPGs concerning those matters would be much more cordial.

(3) Due to time constraints the Program Office had to structure the contract with the best information available and there was no MOU to refer to. Therefore, the contract suffers from the shortcomings in definition and detail that are present in the MOU. The real lesson to learn here is that if we must leave terms loosely defined in order to satisfy the political pressures inherent in dealing with foreign governments then we must expect problems in the program later on either with the contractor or the foreign governmemt. The contract can only reflect the conditions as the negotiators understand them at the point in time the contract is signed and no amount of careful wording will transfer the burden of an ill defined set of conditions to a contractor. Certainly, we should not agree to set percentages of an ill defined dollar value for co-production commitment nor should we tie ourselves to an NTE and co-production figures without firm criteria for determining when foreign industry has priced itself out of the program.[79]

The same study further stated...

It is unlikely that the offset agreement can be met within the F-16 program. There is some doubt that it can be met at all. Fulfillment of the commitment milestone is "on or before the delivery to the U.S.G. and the EPG of the 1,000th F-16 aircraft and/or AGE, initial spares, etc., whichever is later. The USG fulfillment of the 80% target offset reached on assumed third country purchases of 500 F-16 aircraft (total purchase of 1500) shall also be progressive." Any offset commitment poses a significant management problem

but we must assume they will be required on future programs and that no matter how we try to hedge on words the Europeans will look upon the numbers we offer as a guarantee.

On the basis of the F-16 experience the DSMC study made the following recommendations for future co-production programs concerning the MOU and the role of the program manager.

> Since Memoranda of Understanding have assumed the force and effect of a contract, it is imperative that great care be exercised in the construction of these documents to ensure that what is being promised can be done. In this regard, it is strongly recommended that the accountable agent for accomplishment (normally the Program Manager) be a member of the team negotiating the MOU.
>
> The MOU should be a top-level document which establishes general aims and interrelationships. It should incorporate a provision for the establishment of an executive body, such as the F-16 Steering Group, to work out the necessary implementation details.
>
> The Program Manager should be provided direct access to the Steering Group, the U.S. Steering Group Member and Decision Maker. This provision will likely cause elements of the normal administrative chain of command to be bypassed. However regrettable this may be, the Manager is the focal point for action items and an abbreviated reporting chain is necessary if he is to be able to respond in a timely manner...
>
> A separate charter clearly defining the scope of his authority and responsibility should be provided the Program Manager of any multinational program such as the F-16. The charter should ensure that the Program Manager is the focal point for all matters dealing with contract execution but must also make clear that the Program Manager is not able to commit the U.S. Government.[80]

All things considered—that the Air Force had to structure, negotiate and award the F-16 contracts in a compressed time frame; that the selection of a fighter and the signing of the MOU continued to slip over the subsequent 5 month period; and that the co-production contracts and the signing of the LOA's were to be completed within the following six month period, when in fact, they took

a year longer than planned— the five governments concerned can be credited with having done an admirable job of pulling the program together.

The DSMC Study offered the following commentary on their dilemma:

> "In summary the major lesson from a contract point of view is that we can operate in a very compressed time frame but we must expect major turbulence in the program as it progresses. If the political arena is such that in order to be responsive we must disregard certain basic principles of contracting then management must be prepared for problems in contract interpretation, delays in processing contractual actions and questions regarding contract enforceability."[81]

7. Configuration Management Control

a. Configuration Control

Among the most difficult challenges facing the program was configuration management. Configuration control and standardization are always critical elements in maintaining cost and schedule goals through all places of a project. A dilemma results as operators press to optimize the performance of the system, while program managers struggle with keeping the product at cost. The impact of "user" inputs for configuration changes in a multinational program can be a severe problem.

The Europeans entered as full fledged partners on the government side of program in June, 1975, upon execution of the MOU and the preliminary contracts, several months after full scale development had commenced.

> These preliminary contracts contained changes each of the new partners wanted in order to tailor their version of the aircraft to meet their own peculiar requirements. By the time the Europeans entered the program, however, the F-16 had three years of engineering definition behind it and any change carried with it a significant price tag which the country or countries proposing the change had to pay. The cost factor rapidly reduced the shopping list.[78]

Upon the arrival of the teams at the SPO of several national representatives from each EPG, the Senior National Representative of each team was made a member of the F-16 Configuration Control Board. This Board was charged by the USAF chief of staff with deciding on the acceptability of changes proposed by the contractors and user air forces while maintaining design-to-cost goals. It was chaired by the deputy chief of staff for R&D, included key representa-

tives from U.S. user and support commands, and was expanded to include the Europeans. In the words of the Program Manager, General Abrahamson: "This body thoroughly scrubs new requirements and adds real discipline to the F-16 acquisition effort."[79]

With five air forces involved, keeping the aircraft identical was problematic, but in time, changes were reduced to a handful, and fell into three categories:

(1) Common changes, accomplished in the complete inventory, the cost of which was shared by all 5 nations;

(2) Country peculiar changes, for which the individual nation bore the total recurring and non-recurring costs;

(3) Multi-national changes, for which the costs were shared on a pro-rata basis by two to four nations.[80]

Options that have been incorporated into all 5 nations' aircraft are: sea clutter elimination from the radar; radar picture freeze; navigation update capability; a radar electro-optical video recorder; a high technology ejection seat; back-up fuel control; heads up display symbology; inertial-navigation system automatic variation insertion; an auto-pilot attitude hold feature for the radar; and advanced corrosion protection for the radar. Only the last two of these changes were of European origin.[81]

Country-peculiar change costs were paid by Norway to equip their aircraft to carry specified missiles, and to install drag chutes. Denmark and Norway shared costs to have their aircraft provided with a particular positive identification system. All other European change proposals were withdrawn when the cost became known.[82]

Other changes considered but rejected have been: the Harpoon anti-shipping missile, which Norway and Denmark asked to be studied; wind-shield anti-icing, telebriefing capability, autopilot Mach throttle hold, and weapon certification. Also deleted have been a proposed radar altimeter and an instrument landing system.[83]

One breach of this preconsultation arrangement with the Europeans for configuration changes occurred in November, 1976, involving the ejection seat. The ejection seat of the F-16 had been replaced by another in common with several other U.S. aircraft, as part of an intra-national standardization effort. Due to fumbled inter-departmental coordination, the EPG's had been left out of the loop and found themselves presented with a 'fait accompli'.

The EPG eventually agreed to go along, but argued that the U.S. should pick up the cost of termination of contracts by itself. The F-16 SPO pointed out that it could not legally do this. In the end the EPG's paid the termination cost of several million dollars, while they received in return aerospace ground support equipment provisions data for support of their aircraft, legally satisfying the costs incurred in seat termination.

In spite of this, one 'slipped through the crack' case and the two minor deviations mentioned above for the Scandanavians, the program manager was able to state in 1977:

> As five sovereign nations go about the detailed analysis of tactical doctrines, mission usage, and resultant F-16 equipment selection to meet particular requirements, it might be expected that different equipage and configuration will occur. This has been true in the past, when economic and political factors were applied to potential common programs. This is not the case with the F-16...In addition to the production economics and operating advantages of a universal F-16, the benefit in having similar support equipment training equipment, and maintenance and training philosophy can be applied. These benefits yield a broader market for support equipment and allows the quantity increase so necessary for economical coproduction. Further a pooling of spares and joint usage of depots provides large potential cost savings over the program lifetime.[84]

The 1978 DSMC study summed up the issue as follows:

> Change control in the F-16 has been exercized to a nearly unprecedented degree as a result of the small size of the prototype and the pressure of cost control.[85]

Though the EPG's had only a minor impact on the F-16's ultimate configuration, the overall cost impact was positive, in that the program's multinational character (combined with the program's advanced stage of development) meant that U.S. cost problems would also become European cost problems and vice versa. This served to restrain cost increases for all five nations.

This experience can be contrasted with the configuration control and cost problems encountered on the NATO PHM hydrofoil project, which undermined support in all three participating governments, and eventually contributed to, the Italian withdrawal in 1974, and later a German pull out in 1977. Only the U.S. entered series production, and this was for five additional ships (for a total of six) in lieu of the 30 originally planned.

b. The Choice of an ECM System (1979-80)

The first major F-16 system modification (and therefore destandardization) following the start-up of series production involved the choice of electronic countermeasures (ECM) system. This involved the issue of intranational versus international standardization and differing conceptual approaches affecting trade-offs between the advantages of an externally mounted pod system versus and those offered by an internal system.

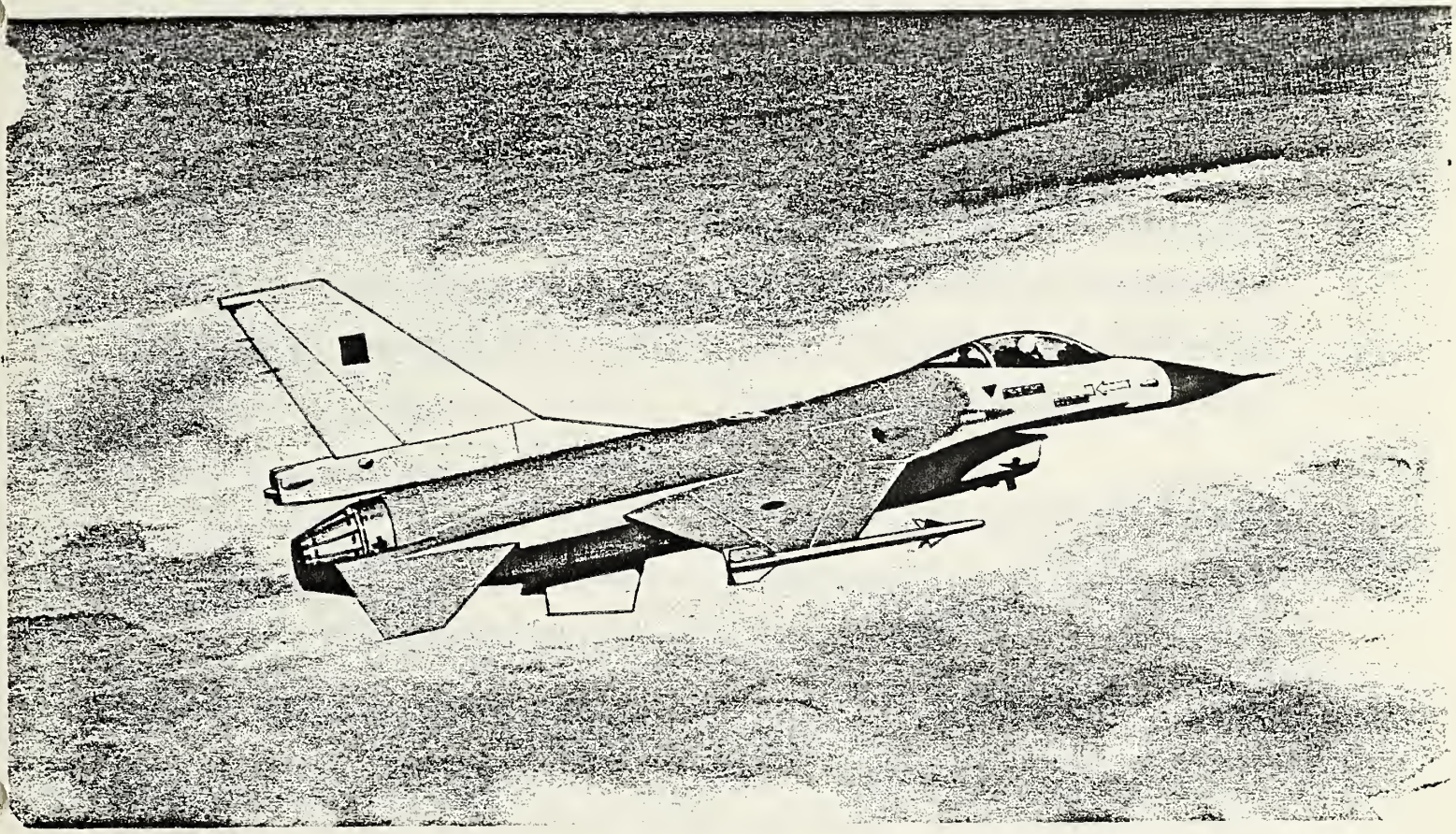
(1) The Belgian Decision

The Belgians were the first to step over the Travis line. In late July 1979, six months after accepting its first F-16 off the SABCA production line at Gosselies, the Belgian Air Force selected the internally installed Loral Rapport_III ECM system for its F-16 fighters. The Rapport (rapid alert programmed power management of radar targets) was selected over competitive systems from Sanders Associates/SABCA and ITT Avionics/Bell Telephone Manufacturing Co.

Belgian officials said the decision to use the U.S.-designed internal system was made after a USAF concept of a podded externally mounted system was discarded by the Belgain air staff. The Belgain Air Force decided to go with an internal system because a pod creates drag, reduces speed and creates a hard point on the aircraft.

Belgian selection of the ECM system was the first adoption of an ECM device by any of the participants in the F-16 program. No other nation was to join the

Out front.



Loral has Rapport with the F-16.

Protection is the name of the game. The continuing evolution of radar directed threats is a constant challenge to our ECM technology. Loral's Rapport III system, designed for the F-16, meets the challenge—now, years ahead of potential alternate solutions.

Rapport is a totally integrated EW internal self-protection system employing a new high-speed digital processor, a wide-band acquisition receiver, and multi-functioned computer-controlled noise, CW, repeater-deception modes to defeat the more sophisticated radar threats. Now in development are modules for higher emitter radiated power and a millimeter wave capability needed to cope with evolving radar threats.

Loral is developing the techniques and hardware that will assure the continued effectiveness of its radar warning and power management system for the Air Force F-15. It has developed and enhanced a warning capability to update the radar warning systems for Navy aircraft. Loral's new microprocessor will enable helicopters to operate in increasingly dense threat environments. These programs are definitive state-of-the-art ECM.
Loral Electronic Systems, 999 Central Park Avenue, Yonkers, New York 10704, is where it's at.

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Move out front.
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Belgians, although several originally expressed interest in the ECM system, especially with its internal mounting characteristic.[86]

The Rapport III system employs a crystal video, amplitude comparision radar warning receiver subsystem for threat acquisition, analysis and identification, and has a programmable digital processor to perform power management or jamming power allocation functions.[87]

The Loral system had also been selected by the Belgian Air Force for its Dassault Mirage 5R and 5BA aircraft. F-16 selection was in part based on successful completion of tests in the Mirage aircraft and an interest in maintaining intra-national standardization. The first Rapport was installed in a Mirage 5R in early 1977.[88]

The ECM system was to cost about $100 million for all the Belgian F-16s. Funds were set aside in the original budget when Belgium selected the F-16, so additional funding was not called for.

Belgian F-16 work was scheduled to begin in the fall when Loral was to submit its installation plans to General Dynamics. The ECM equipment was to be tested the following spring.

All Belgian F-16's after the 55th would have the ECM system installed in line prior to delivery. Earlier aircraft would be retrofitted. The retrofitting would not entail structural modifications, but would consist of extensive

internal work, including avionics modification in the cockpit and center and aft fuselage.[89]

Belgian officials expressed hope at that time that USAF would join in a cooperative development program for incorporating the Loral system into the F-16. The possible participation of the other coproduction nations was also looked into. But, as no other F-16 partners could be interested, Belgium had to foot the bill alone for the non-recurring costs.

(2) The USAF Decision

The debate over the choice of ECM system for the F-16 had also been underway for some time in the U.S. The Congress had supported greater consideration being given international standardization and in particular to the Belgian decision in favor of the Rapport III, while the Pentagon and the Navy supported another internal system (the Airborne Self-Protection Jammer (ASPJ) and were trying to get the Air Force to adopt it for the F-16. The Air Force, however, favored selection of its external ALQ-131 system already under order for other of its aircraft, i.e., leaning toward intra-national standardization as the Belgians had with the Rapport III.

The previous spring the House Armed Services Committee had blistered the Air Force in its fiscal 1980 report over the service's "indecision on equipping the F-16 with the ASPJ." While complaining about the proliferation of electronic jamming systems, the House panel said the Pentagon should look at the Loral Rapport III in line with the Belgian decision.[90]

The Belgian initiative had the effect of accelerating decision making in the U.S. About two months after the definitive Belgian decision to extend its use of the Rapport III from its Mirage 5's to the F-16 as well, Air Force Assistant Secretary Robert J. Hermann (R&D and Logistics) was reportedly seeking to persuade various Air Force commands to arrive at a consensus within several weeks on whether the F-16 fighter should have an internal or external electronic jamming system.

Hermann wanted to nail down the decision on the F-16's electronic countermeasures system in time for the fiscal 1981 budget hearings early the following year and thereby avoid further congressional criticism of the Air Force on the issue.

DoD plans called for the ASPJ's adoption as a common system for both the Air Force and Navy and possibly the Army as well. The Navy was committed to the ASPJ for its F-14 and F-18 fighters, and for pod use on the AV-8B. The Army was also interested in possible application of the ASPJ to its twin-engine aircraft and small helicopters. Since the Army had been in electronic warfare a relatively short time it was following the lead of the other services.[91]

The three European F-16 nations yet to make a decision received at this time several presentations on the subject. They expressed an interest in the ASPJ, but wouldn't make a commitment until the Air Force decided.

Pentagon sources had discounted the Rapport III all along as a real threat to the ASPJ. The Rapport III could do the job in 1979, they said, but couldn't

match the long-term promise of the ASPJ. The latter with an initial operational capability of 1986 was intended to be capable of meeting the threat out to the year 2000.

They also pointed out that the Rapport III was designed for the Mirage which had a smaller radar cross section than the F-16.

This source called the Belgians "babes in the woods" in the complex and costly world of electronic warfare and noted that Belgium was the first NATO F-16 consortium member to strike out on its own in EW. Furthermore, it was suggested that planned coproduction of the Rapport in Belgium may have influenced the decision.[92]

The Air Force for its part was reluctant to commit to the ASPJ for its F-15 and F-16 fighters. They not only had no requirement for an internal electronic system, but were having trouble with the fact that the ASPJ would not be operational until the mid-80's. Source selection between the competing Northrop/Sanders and Westinghouse/ITT teams was still over a year away. In the end, the Air Force remained firm in its support for the on-going Westinghouse ALQ-131 comprehensive power management system and selected the system for its F-16 that fall.

(3) The Dutch Decision

The following summer, in August 1980, the DoD responded to a Royal Netherlands Air Force request for a Letter of Offer and Acceptance (LOA) for its F-16's

for 13 of the ECM pods with an option for an additional 62 ALQ-13's. The RNAF counted on rapid parliamentry approval of its decision with no problem expected in meeting the October 1 deadline for signing the LOA.[93]

The approval process was unexpectedly slowed, however, by a series of reviews and hearings that rivaled the Netherlands' focus on the Northrop scandals and on the original selection of the F-16 fighter. The Dutch press covered the debate in detail. The deadline for the RNAF to sign the LOA had to be extended initially until mid-October, and then until November 15.[94]

First, when the RNAF presented the DoD's proposal in mid-September, the parliament requested more information. By October 22, when the RNAF had assembled additional data supporting the program a part of the government was supporting the Loral Corp.'s Rapport-III internally-mounted ECM system. On November 1, Parliament sent detailed questions to the U.S. Air Force on the ALQ-131, and to the Belgian Air Force for its Rapport III. On November 3 representatives of Loral, Westinghouse, General Dynamics and Hollandse Signaalapparaten testified before the parliment, and on November 5 a final hearing was held during which the RNAF was given approval to "react positively" to the Pentagon's offer.[95]

The LOA was finally signed by the Dutch on November 11 at their embassy in Washington, D.C. and subsequently delivered to the Pentagon.

The ALQ-131 was finally chosen, according to participants in the debate, because it was already in use by the U.S. Air Force. The bottom line was that

the labor party had to back down from its position of support for the Rapport III because the Dutch defense minister emphasized that it was better to stay common with the USAF.[96]

Supporters of the Rapport III pushed the point that it was less expensive and, because it would be mounted inside the F-16, had less effect on the aircraft's performance. In addition, they said, it would be better at jamming targets "above the horizon", and wouldn't be any problem to fit aboard the two-seat F-16B.[97]

On the other hand ALQ-131 supporters had been stressing that, besides being a "fully mil spec qualified" USAF system, no aircraft modifications were required and deliveries could begin the following spring. They put the price of an ALQ-131 at $755,000, and said an installed Rapport III would cost $892,000.[98]

Signing by November 15 was important because it allowed the Dutch to get in on the U.S. Air Force's Lot V buy of ALQ-131's—as many as 140 pods. December 1 was the date of this buy, and it would add to the 288 pods already ordered by the USAF in four earlier lots. Excluding FMS orders, of which the RNAF's was the first, some 1100 pods were to be built by Westinghouse for the USAF.[99]

Loral had acknowledged one of the criticism's leveled against their system; that the Rapport III was behind schedule in its flight test program. Testing was to have started that month at Eglin AFB, Florida, but had slid to the following March. The reason for the delay was that the Belgian Air Force

wanted to complete all rigorous bench tests and qualification tests before the flight tests so they would be prepared for an immediate production turn-on. The slip "was a mutual thing for all parties."[100]

Lack of a sale to the Netherlands, a Loral spokesman said at the time, wasn't a serious setback because the company had "other viable customers" and because it was cooperating with Westinghouse on the ALQ-131 anyway.

Loral was simultaneously involved in yet another fighter ECM system competition, this one being in the U.K. The Royal Air Force, although having opted for a pod ECM system for its newest fighter, the Tornado—the Marconi Space & Defense Systems Sky Shadow— changed to an all internal ECM system for retrofit to its earlier Jaguar and Harrier fighters. Loral was teamed with Racal-Decca and British Aerospace Dynamics,[101] which were competing with two other teams led by Plessey and Marconi. The three groups were to submit proposals early the following year.

And so it goes in the 'NATO' market place.

8. Contract Administration & Quality Assurance

For the F-16 project effective surveillance by government contract administration services had to be organized and maintained over several levels and numerous facets of contractor activity in Europe. General Dynamics and Pratt & Whitney were prime contractors with total system performance and subcontract management responsibilities for their respective parts of the program for delivery to the USG, whether produced in the U.S. or Europe.

Normally carried out on a continuous basis only at the prime contractor's facility, surveillance of the prime contractor's subcontract management effort is the responsibility of the cognizant government contract administration office, which in this case was the local Air Force Plant Representative Office (AFPRO). Here, special measures were required for the division and delegation of contract production, and contract administrative services (CAS) functions among the USAF's Logistics (AFLC) and System Commands (AFSC) and the EPG's.

Within the Air Force a memorandum of agreement was worked out between the AFLC and the AFSC. The AFLC's Detachment 16 of the Air Force Contract Maintenance Center (AFCMC), is located in the Federal Republic of Germany and has responsibility for contract administration of U.S. defense work in Europe generally, while the AFSC, its System Program Office (SPO) and the EPG's had worked out an arrangement which established a European System Program Office (ESPO) to handle program management in Europe. In addition, the AFSC desired a dedicated contract administration organization in Europe to be responsible for the F-16 contracts and therefore established Contract Administration Services

Europe (CASEUR) as an activity under its AFSC Contract Management Division (AFCMD). The memorandum of agreement between the AFLC and AFSC provided that:

> ....AFLC will retain their present area cognizance over CAS in the EPG countries except for the F-16 contracts to be administered by CASEUR, and will continue to be responsible for CAS in the rest of Europe including F-16 contracts. AFLC's F-16 contracts (Warner Robins) in EPG countries will be administered by CASEUR, not AFCMC. Delegations of F-16 CAS authority to AFCMC's Detachment 16 in non-EPG countries will be made from CASEUR in all instances where U.S. CAS is required. Otherwise, the CAS capability of the host Government will be used.[102]

As the system Program Office at Wright-Paterson Air Force Base, Ohio, ESPO and CASEUR began to function together, responsible managers recognized that the ESPO actually duplicated functions of the other two organizations with the resultant layering of management being counter-productive. Consequently, the ESPO was subsequently eliminated with its functions being taken over by CASEUR and the Program Office.[103]

Though resisted at first, the EPG's eventually consented, with the signing of Technical Agreement No. 1, to CASEUR's establishing Operating Locations at their industrial plants for the F-16 program. The Operating Locations were manned with a mix of US government and host nation personnel under the command of a representative of the host nation.[104]

One of the points of contention that took several months to hammer out was over the USG's on site individual exercising of signatory authority on the DoD's standard shipping/receiving/inspection form (DD Form 250). The EPG's did eventually agree to a US signature.[105]

As in other areas, the E^G's objected to the highly structured USG surveillance requirements for quality control being imposed upon their contractors. Reflecting differences in the European and North American industrial relations environment, European firms have extremely low employee turnover rates. This means the European firms can rely on higher skill levels than their American counterparts who must deal with a more transient society. Utilizing lower skill levels and having to live with higher manpower turn-over rates, the U.S. has compensated by developing detailed production instructions and lengthy written procedures. The Europeans therefore, naturally resent having to prepare and use these lengthy procedures for control of production or quality that are meant to apply to a foreign environment. The DSMC study reported that the EPI prepare such procedures as required to satisfy contract requirements, but then, generally, place them on the shelf for reference.[106]

As with inspection in other areas, the European governments and industry consented after negotiations to the U.S. sending in itinerant quality assurance people and utilization of the Allied Quality Assurance Publication (AQAP), with any additional quality requirements the USG feels necessary being specified in the applicable contracts. A summary of GD's experience in comparing the AQAP and U.S. quality documents provided in the DSMC study is shown in the figure on the following page.

AQAP/STANAG DOCUMENT

o EXPERIENCE TO DATE AT GENERAL DYNAMICS ENCOMPASSES FAMILIARIZATION WITH THE FOLLOWING AQAP/STANAG DOCUMENTS:

	ALLIED QUALITY ASSURANCE PUBLICATION (AQAP)		UNITED STATES COUNTERPART	
*	AQAP-1	"NATO QUALITY CONTROL SYSTEMS REQUIREMENTS FOR INDUSTRY"	MIL-Q-9858A	"QUALITY PROGRAM REQUIREMENTS
	AQAP-2	"NATO QUALITY ASSURANCE HANDBOOK"	HANDBOOK H50	"EVALUATION OF A CONTRACTOR'S QUALITY PROGRAM"
*	AQAP-4	"NATO INSPECTION SYSTEM REQUIREMENTS FOR INDUSTRY"	MIL-I-45208A	"INSPECTION SYSTEM REQUIREMENTS"
	AQAP-5	"GUIDE FOR THE EVALUATION OF A CONTRACTOR'S INSPECTION SYSTEM"	HANDBOOK H51	"EVALUATION OF A CONTRACTOR'S INSPECTION SYSTEM"
*	AQAP-6	"NATO CALIBRATION SYSTEM REQUIREMENTS FOR INDUSTRY"	MIL-C-45662A	"CALIBRATION SYSTEM REQUIREMENTS"
	AQAP-7	"GUIDE FOR THE EVALUATION OF A CONTRACTOR'S CALIBARATION SYSTEM FOR COMPLIANCE WITH AQAP-6"	HANDBOOK H52	"EVALUATION OF CONTRACTOR'S CALIBRATION SYSTEM"
	AQAP-9	"NATO BASIC INSPECTION REQUIREMENTS FOR INDUSTRY	P.O.S.T.&.C.	"PURCHASE ORDER STANDARD TERMS AND CONDITIONS"

NATO STANDARDIZATION AGREEMENTS (STANAG)

*	STANAG NO. 4042	"RULES FOR THE CONVERSION OF UNITED STATES AERONAUTICAL DRAWINGS (AIRFRAMES) FOR COUNTRIES EMPLOYING THE METRIC SYSTEM"
*	STANAG NO. 4107	"MUTUAL ACCEPTANCE OF GOVERNMENT QUALITY ASSURANCE"
*	STANAG NO. 4108	"NATO INSPECTION AND QUALITY CONTROL REQUIREMENTS FOR INDUSTRY AQAP-1, AQAP-4, AQAP-9"

SOURCE: DEFENSE SYSTEMS MANAGEMENT COLLEGE

ICORPORATED INTO PURCHASE ORDERS

The AQAP documents, like their counterpart United States documents, deal with administrative and management systems, and are not complete operating programs which can stand alone. They must be supplemented by specific purchase order/subcontract instructions to assure contract compliance. Individual assessment of the particular procurement and the selected supplier requires individual purchase orders to be specifically tailored to that procurement and supplier.

The flowdown of AQAP and additional Quality requirements from GD to European supplies was a requirement included in the contractor's quality program plan which was incorporated into the F-16 contract.

As of mid-1978 when the DSMC study was completed on the F-16, the use of AQAP and NATO Standardization Agreements (STANAG) has caused no major problem in F-16 contract administration. However, since production had not yet progressed to the point where large numbers of aircraft are being delivered it was too early to evaluate the effect of using AQAP and European inspectors. The DSMC study recommended that results experienced by the Air Force be closely tracked to determine what problem areas arose so that future programs can make allowances in their quality programs.[107]

The following provided a little more in the way of specifics. It is derived from a review by D.D. Burchfield, Assistant for Quality OUSD (R&E) SS, entitled "Lessons Learned through Review of the F-16 Aircraft Consortium Arrangement" issued on March 29, 1979.

> Allied Quality Assurance Publication (AQAP) #1 was supplemented extensively on the F-16 program contracts to European subcontractors. There were some paragraph changes that have little impact on the quality of the products being produced. The most productive of

these supplements were requirements for: non-conforming materials control; lower tier subcontract controls; configuration management or engineering change control.

These supplemental controls are essential to any co-development or co-production program because most of the European nations do not require these controls in contracts.

As of that time, the NATO Group of National Directors for Quality Assurance (AC/250), Subgroup VIII was developing a revised AQAP-1 which would incorporate these three areas of control. Until the revised document was available, it was essential that these controls be incorporated in co-development--co-producer subcontracts.

Burchfield's recommendations on this point were:

(1) DoD Components should not attempt to re-write paragraphs to supplement AQAP-1.

(2) Contracts or subcontracts to European industry should contain requirements for non-conforming material, subcontract, and configuration or engineering change controls until such controls are incorporated into NATO quality assurance publications.

Not only were U.S. procedures and work instructions superimposed on the European production methodologies, but as we've already seen, U.S. personnel were sent in to duplicate the quality assurance or inspection functions of the existing national governments' plant representatives. The resentment caused by the EPG's feeling that they had the capability to perform such inspections for the USG, was further compounded by the fact that they would have provided the services at no expense if not for the U.S. refusing to reciprocate. All NATO nations, except the U.S., had previously agreed that, as a matter of policy, quality assurance and inspection services would be provided without

charge in procurement between member states. "The failure of the U.S. to ratify this agreement has been a repeated source of friction within NATO."[108]

Though several of the NATO nations do not currently have this capability, they are continuing to develop their government source inspection organizations so as to perform the services for themselves and other NATO and EEC countries.

Quoting the March, 1979 Burchfield review of this situation:

> Charging by NATO nations is the exception rather than the rule....It is important and cost efffective to utilize these services wherever they exist.[109]

Following the release of this review an Office of the Secretary of Defense (OSD) study group was formed to evaluate European country capabilities to perform various contract management functions throughout Europe. Once the capabilities were known, the U.S. would be able to utilize the services available and reduce the DoD component contingents in Europe that were being utilized for this purpose.

A major political impediment was cleared from the DoD's path in October, 1979, when Congress enacted PL-96-92, International Security Assistance Act of 1979. The pertinent language reads:

> The President is authorized to provide (without charge) quality assurance, inspection, and contract audit defense services under this section-- (1) In connection with the placement or administration of any contract or subcontract for defense articles or defense services entered into after the date of enactment of this subsection by, or under this act on behalf of, a foreign government which is a member of the North Atlantic Treaty Organization, if such government provides such services in accordance with an agreement on a reciprocal basis, without charge, to the United States government; or (2).... (This part concerns similar services to be provided for the NATO Infrastructure Program, see Chapter 2.)

9. Finance

a. Progress Payments and Multi-Year Funding

In December 1975 the F-16 Program Office informed senior Air Force officials that due to financing arrangements, its US prime and subcontractors had reached an impasse in their efforts to place subcontracts in the 4 European nations. The European industries involved, were demanding their customary financing terms, i.e., either 100% progress payments on a bi-monthly basis and within 10 to 20 days of billing, or advance payments. At that time the normal rate allowed by ASPR was monthly reimbursements for 80% of their costs and a 30 day billing rate, with authority to go to 90%. Futhermore, US contractors cannot pass on the cost of borrowing the rest to the USG.

For the European industries concerned, accustomed to being paid everything, including profits, as they go along, these terms appeared to be outrageous. As General Dynamics vice-president in charge of the F-16 program, Blaine Scheideman, put it,

> "This was a monumental problem for some of them that didn't have any cash to speak of in the bank."[110]

The USG agreed to process an EPG request for an increase in the normal progress payment rate for European subcontractors to 90%, if substantiated by their submittal of the relevant documentation. Subsequently the DOD Contract Finance Committee approved the request for 90% progress payments to European subcontractors twice a month within 10 days of billing on the F-16 co-

production program. The rationale for their approval was stated in a memorandum dated June 14, 1976 and read as follows:

> Our consideration of your request for deviation has been based on the following factors: (1) the DoD commitment under the MOU, (2) the funds to be expended under the EP Subcontractors are principally EP Government funds provided under an FMS arrangement, (3) the fact that the EP Governments originally intended that their funds be expended with their subcontractors in accordance with customary European financing arrangements, i.e., either advance payments or 100% progress payments, and (4) the substantiating data submitted by the EP Governments indicate that progress payments, even at the 90% rate, are less favorable than customary financing arrangements on contracts awarded by their governments for services and articles of comparable complexity.[111]

The Program Office proceeded to incorporate the provisions into the contracts with GD and Pratt & Whitney.

In a later action the ASPR Committee authorized 90% progress payments for all new FMS contracts for the F-16 whether coproduction was involved or not.

> The Contractor, aware of this authorization, made 90% progress payments a subject of negotiation on ECP 0006 which would, among other things, exercise an option for Consortium aircraft. This complicated the issue for the F-16 Program Office since the EPGs were already having a problem meeting the existing payment schedule. Briefly, the SPO incorporated 90% progress payments for the airframe prime and subcontractors into ECP 0006. The EPGs have stated they will accept the obligation only if it does not impact their payment schedules.
>
> At this time the impact of increased progress payments had not been fully assessed and the issue remains open.
>
> In future programs where co-production is a factor the initial payments schedule should reflect the 90% rate and we should be prepared to make further adjustments for European subcontractors.[112]

In dealing with another European subcontractor concern, it was the 4 EPG's that helped out the US contractors. The European firms were expecting firm

commitments for hundreds of planes, but the USG only buys in annual installments.

This seemed to many of the European subcontractors a risky foundation on which to make heavy investments in production equipment for the F-16. Eventually, the EPG's dampened the risk by at least guaranteeing most of their full orders for fighters.

b. Payment Schedules

In computing Funding Plan requirements, the SPO constructed an expenditure profile for the EPG portion of the F-16 program (from which it then developed the progress payment profile). During the Multi-national Fighter Program Steering Committee meeting held in Brussels, Belgium on December 8, and 9, 1976, the EPG representatives expressed dissatisfaction with the several points of their 4 LOA's.

Chief among these several concerns was the "front loaded" payment schedules. Belgium, Denmark, and Norway had particular problems of funding shortfalls in the early years of the program, while the Netherlands had problems over their budget cycle to funds requirements. After consideration of several options legally available, the USAF developed, in light of the partnership nature of the program, a three-point financial arrangement to ease the EPG funding problems.

One, the normal FMS cash advances required to cover potential termination costs were waived for all 4 EPG's. However in accordance with Section P of the MOU, the EPG's are still responsible for termination costs.

Secondly, authorization was obtained allowing the EPG's the option of deferring the payment of R&D costs, established at $470,000 per aircraft. The recoupment of these nonrecurring costs would normally be assessed upon delivery of the aircraft.

Interest will be charged at the prevailing treasury rate on all R&D deferred recoupments at the time deferment occurs. Acceptance of this option varies by country as follows:

Belgium - payment of R&D recoupment delayed until 1984;

Denmark - payment of R&D recoupment delayed until mid-1980;

The Netherlands - payment of R&D recoupment will be paid upon aircraft delivery;

Norway - payment of R&D recoupment delayed until mid-1981.[113]

The third point included a U.S. Treasury agreement to accept advanced payment from any of the EPG's, and invest and disburse these funds against F-16 program requirements. The Netherlands was the only country to opt for this

arrangement, making an advanced payment of $60 million from excess F-16 funds available in CY 77 and CY 78.

> Notwithstanding the fact that these special arrangements were made there is still a distinct possibility that, due to fiscal constraints, some of the EPGs may not be able to meet the payment schedules in their LOA. Should this occur the Consortium F-16 account may not have sufficient funds to cover the shortfall and the Program Office would be faced with the unpleasant necessity of ordering the contractors to stop work.
>
> The possibility exists that this situation could be handled through short term, interest bearing, loans by the contractor and the Air Force is pursuing this option. The EPGs are receptive to the idea as are both major contractors and the Air Force has drafted implementing contractual terminology and begun negotiations. One contractor, however, is insisting on a U.S. Government guarantee of the loan as a non-negotiable condition which the Air Force, from a legal standpoint, cannot accept.[114]

This possible problem area remains open and is without final solution at the present time.

In summary, the Air Force was able to provide some relief for EPG funding problems through the process of obtaining waivers to existing directives. As pointed out in the DSMC study, part of the solution to front loaded payment schedules lies within the waiver authority available to the DOD and the DOD should consider blanket waivers to prepayment of termination liability and deferring R&D recoupment whenever cooperative programs with foreign allies are contemplated.

c. Contractor Capital Investment Incentives

As the F-16 program progressed officials in OSD and the Air Force recognized that the program could benefit from special termination protection being pro-

vided the contractor so as to increase the incentive for capital investment. Referring to a previous Deputy Secretary of Defense Memorandum—"Capital Investment Incentives for Contractors," Enclosure 2 to Attachment 1, W.P. Clements, 21 May 1976—the Acting Principal Deputy Assistant Secretary of Defense (L), Dale Babione, granted authority to use a special termination buy-back technique.

In essence the technique authorized arrangements to be made, in the event the program was partially or wholly terminated, whereby the contractor would sell to the USG capital investment items for their amortized value.

> The real value of the clause is hard to quantify but in view of the uncertainties in a cooperative program with foreign countries this special provision should provide incentive to the contractor to make capital investments which benefit the services. The clause developed for the F-16 should serve as a model for other programs.[115]

d. Abnormal Escalation Rates

In providing for abnormal escalation rates in the contracts, each EPG provided the price indices that would apply to their own subcontractors for both upward and downward adjustment. These will be reflected in the price adjustments to the prime contracts and will be allocated to contractual effort in the time frame involved, being recomputed every six months. The amount of the adjustment is then prorated to each of the 4 EPG LOAs payment schedules in accordance with the level line pricing agreement. With regards to economic price adjustment, the DSMC study offered this,

The lesson learned is that it takes the EPGs a great deal of time to develop these indices and, therefore, they should be developed early so as not to impede contract negotiations.[116]

e. Foreign Exchange Arrangements

The five governments agreed in the MOU that currency exchange procedures be formulated on the basis of the principle that companies participating in the program were to be insulated from fluctuations in foreign exchange rates. To insure that this provision of the MOU was met the Air Force Accounting and Finance Center (AFAFC) of Denver, Colorado established the Currency Clearning House (CCH) in Brussels, Belgium. The CCH established accounts in the four EPC's to handle the continuous foreign exchange transactions of the program's contractors. In supplement No. 1 to the MOU the following schedule of fixed rates of exchange (in effect in October 1975) was agreed to for subcontractor billing and payment by the primes:

Belgian Franc	38.660 per $1.00 U.S.
Danish Kroner	6.015 per $1.00 U.S.
Netherlands Guilder	1.663 per $1.00 U.S.
Norwegian Kroner	5.520 per $1.00 U.S.

Under the arrangement the five participating governments initially deposited a currency stock in the clearing house on the basis of their participation in the program. As progress payments are drawn by the U.S. and European manufacturers as needed, the currency stocks are replenished by the governments in

the form of payments for their F-16's.[117] The four EPG's make these deposits to a U.S. Treasury account maintained by the AFAFC based on their quarterly DD Form 645, Foreign Military Sales (FMS) Billings. Then, for example:

> An EPG contractor bills the Prime for work accomplished under the contract in local currency. The Prime authorizes payment from the Prime's account in the Brussels-situated arm of the Air Force Accounting and Finance Center, specifically established under contract with a commercial bank for the F-16 program, the Currency Clearing House. The Prime's payment is denominated in MOU-equivalent dollars. The Currency Clearing House must then acquire the required amount of foreign currency in the marketplace and pay the prevailing rate for the exchange. The five particiating governments share the burden or benefit of any variance between the MOU rate and that which exists in the international money market at this time.[118]

When the dollar is depressed vis-a-vis the fixed rate, the Europeans benefit, and vice versa. Over the life of the program, the net impact is anybody's guess.

The DSMC study stated that, "The F-16 currency exchange provisions are felt to be worthy of emulation by succeeding programs."[119]

In setting up the CCH the AFAFC elected to place the deposits with a commercial bank which could provide for administration of the arrangement and an account where deposits could earn interest.

The international banking community was offered the opportunity to submit proposals to operate these accounts. As a result, 17 major financial institutions submitted proposals. After analysis of these proposals, the Chase Manhattan Bank, was selected as the financial institution to operate the four

accounts and an operating agreement was executed by the bank and the U.S. Air Force.

Because of the requirement for a central bank to be located in Brussels, the Banque de Commerce, S.A., which is affiliated with Chase Manhattan was chosen as the "lead bank". A branch of the Chase Manhattan bank is the bank used in Denmark, and another Chase affiliate, Nederlandse Credietbank, N.V., is the bank used for the F-16 program in the Netherlands. As "foreign banks" are not authorized in Norway, a correspondent bank relationship was established with the Bergen Bank for transactions in Norway. The CCH deals through the Banque de Commerce in Brussels in transferring and exchanging currencies between the various accounts.[120]

The following flow charts help to better understand this process.

10. Other Intergovernmental and Contractual Issues

a. Reliability Improvement Warranty

While negotiations were underway with prospective avionics sub-system suppliers during full scale development (FSD), the USAF and General Dynamics required quotations from the competing suppliers offering an option for Reliability Improvement Warranty (RIW). Under such an arrangement, the original supplier agrees to repair and overhaul major line replaceable units at a fixed price, and in some instances may be required to guarantee a field reliability figure. In the case of this latter guarantee, if reliability falls below the figure, the contractor must supply the extra spare parts called for, at cost.[121]

The USAF and GD elected to procure five major subsystems under the RIW arrangement: the Westinghouse radar; the Singer Kearfott inertial navigation system; the Lear Siegler flight control system computer; and the Marconi-Elliott Head - up display (HUD) and display electronics.

Since the EPG had not yet committed to buy any F-16's at the time the Air Force negotiated the F-16 contract, the Reliability Improvement Warranty provisions in the original contract call for options to be exercised on US aircraft only.

> Paragraph 63.g. of the contract states that: In the event future production ACF aircraft are sold to the Consortium, the contractor agrees to negotiate with the Consortium to extend warranty coverage ..." In late 1975 and early 1976 the RIW provisions became a topic for discussion in several F-16 meetings and, along with other

> issues, concerned managers raised questions about bringing the EPG under RIW warranty coverage. Most of the issues dealt with our own RIW problems so that in February 1976 senior Air Force officials made a conscious decision not to extend RIW coverage to the EPG until our own problems were settled and to bring the EPG into the RIW Program when we exercised the Air Force RIW option. By Fall of 1976 the Air Force recognized that anything other than a joint RIW program would not be workable or would result in a tremendous cost to the EPGs.[122]

The resultant USG proposal was rejected by the EPG's. The problem was, that the US RIW provisions had been negotiated in a competitive environment, while introduction of the EPG's at this later point would mean their having to pay a considerable premium for obtaining similar terms in a sole source situation. The USG and the EPG's reached an impasse in late 1976 and were still there as of mid-1978. The EPG's claimed the USG had not lived up to its management responsibilities when it elected not to negotiate an EPG RIW option, at the same time it negotiated its own, while the US countered that the EPG's were not yet in the program at the time they were negotiated and furthermore had unofficially mentioned that they were not interested in the RIW option.

The DSMC study provided the following recommendation for future programs

> In the future it appears that, even though it may complicate our program, if we contemplate RIW and foreign involvement in the program is likely; RIW provisions covering the non-U.S. portion should be negotiated at the outset particularly if there is competition at the beginning of the program. At least two benefits accrue; a better price may be obtained and the foreign country would be aware of the cost of RIW before selecting or rejecting that provision.[123]

b. Patent Infringement

Liability for patent infringement during production was yet another area where the FMS-as-usual and partnership aspects of the project were initially a poor

fit. Normal FMS procedures provide for assumption by the purchasing government of any risk of Patent infringement. Since the EPG's viewed it as a cooperative project and outside of normal FMS, another arrangement was necessary.

> A Steering Committee Arrangement provides for revised liability in that EPGs agreed to assume liability for any patent infringement occurring in the EP countries and USG committed to pay its prorata share for foreign patent infringement based on the portion of items produced in an EP subcontractor's plant which are destined for USAF use. The F-16 arrangement appears equitable and should be considered as a model for future programs.[124]

c. Buy American Act

Standard interpretation of the Buy American Act at that time required that, in the procurement of supplies and services, only domestic source end products shall be acquired by U.S. Government agencies. However in those cases where such procurements are necessary, the procuring agency must fully substantiate the requirement on the basis of cost, availability, or related factors that justify procurement of a non-U.S. item. These are handled on a case-by-case basis. For those cases involving the DoD, authorization to waive provisions of the act are granted at the local level for low value items, or at the Service Headquarters or DoD level for larger procurements.

The fact that the Europeans were producing 10% of the procurement value of the USAF acquisition of 650 F-16's, required an exemption. The exemption was issued by Headquarters, USAF, Deputy Chief of Staff, Systems and Logistics, with the approval of the Office of the Secretary of Defense, Defense Security Assistance Agency (DSAA). This exemption was reaccomplished annually.

d. EPG Restrictions on Certain Third Country Sales

Some of the EPG's objected to parts manufactured in their country being used on F-16's purchased by certain third countries in high tension areas of the world. Some national laws prohibit use of goods manufactured in their country by another country engaged in war or likely to instigate one. Since all parts produced in the EPG's were second source this problem was solved by pooling all production parts from both sides of the Atlantic so that they would lose their identity in production aircraft, and by the USG taking delivery of all assets intended for other countries prior to any transfer.

e. Legal Staff

The following quote on the importance of a legal staff for such programs as the F-16 is taken from the 1979 Burchfield review of the F-16 project.

> The legal staff for programs such as the F-16 program are invaluable and essential to completion of agreements prior to and after MOUs are in progress. The legal staffs on the program have not only developed solutions to problems encountered, but can assure compliance to specific requirements of MOUs and contracts. For example, in such a program legal counsel is needed in determining necessary deviations, waivers, and effect or impact of liabilities for actions by U.S. personnel in regard to MOU requirements. Additionally, the legal precedence (history) established on such programs can be invaluable for future programs.
>
> Recommendation:
>
> 1. Legal counsel be obtained for assignment to programs such as the F-16 at the earliest practical date.
>
> 2. That the legal lessons learned on the F-16 program be furnished to future programs such as the NATO Early Warning and Control Program (AEW&C) and other co-development -- co-production programs.[125]

11. Logistics Support

The MOU signed by the five participating governments requires that the U.S. provide:

1. utilization of depot level maintenance and overhaul facilities by the U.S. Air Force Europe (USAFE); established and funded by the four EPG's as well as industry maintenance facilities available in these countries;
2. full logistics and technical support to the four European Air Forces as long as the F-16's are in operational use;
3. aircrew and maintenance training for the Europeans.[126]

Subsequent agreements were also negotiated which provide for: the sharing of spares; interim contractor support; and reliabililty. Ogden Air Logistics Center, Hill AFB, Utah, was designated as the F-16 logistics management center, but direction was scheduled to remain under the director of F-16 logistics at the SPO, Wright-Patterson AFB, Ohio;, through 1981. The Odgen center will be the prime control for F-16 logistics, with responsibilities for subsystem delegated to other air logistics centers, depending upon their specialized capabilities and workloads.[127]

The five PG's agreed upon a common data management system, wherein the four European air forces will be linked to an F-16 system manager at the USAF's Ogden data center.

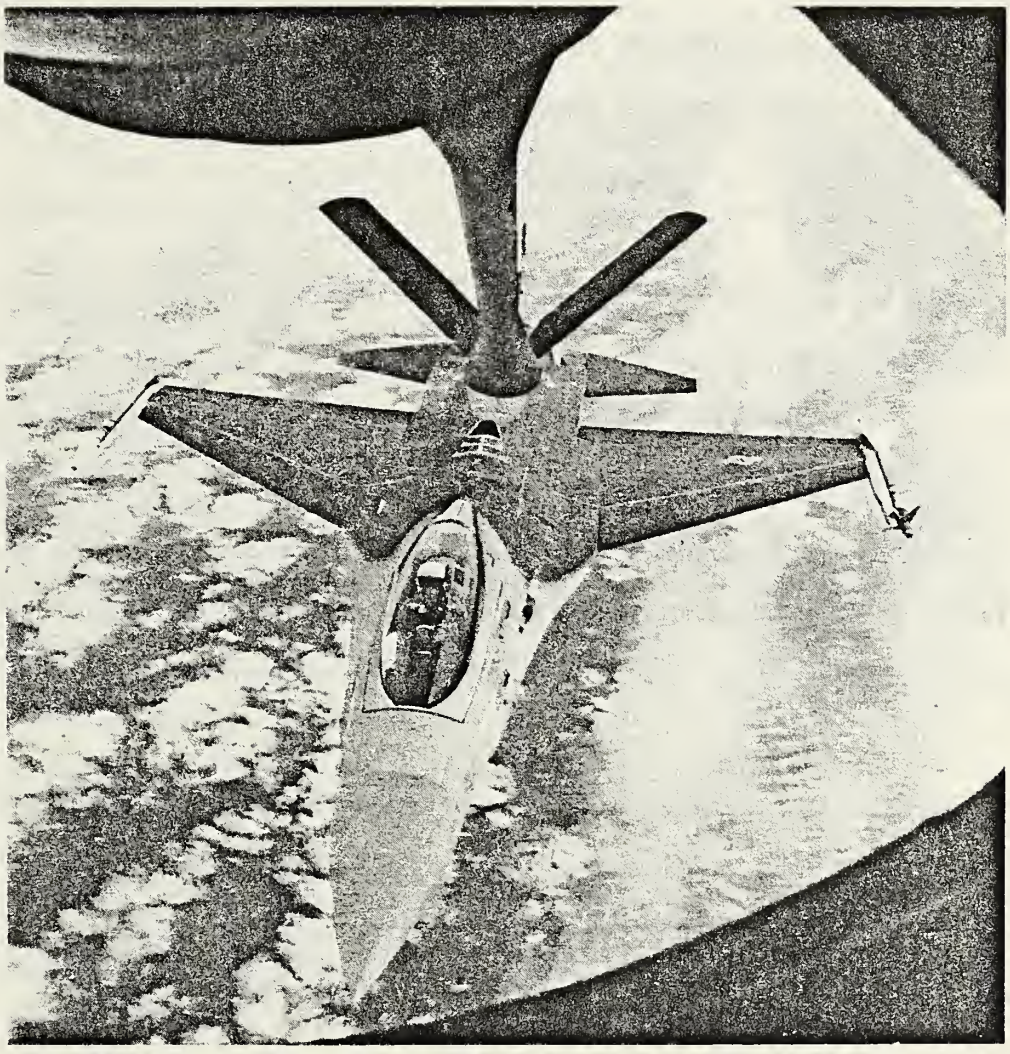
Meanwhile the F-16 SPO's logistics office includes a European division, staffed by three resident logistics officers, one each from Belgium, Norway,

and Denmark. The logistics assignment for the Netherlands is handled by that country's senior representative on Program Manager's staff.[128]

The five air forces operated as a common procurement body in identifying requirements and requisitioning their initial spares provisioning for their F-16's. The five were also planning for a single central European depot for high cost, low usage items (i.e., insurance items). Although there was never any real timetable for this, it was originally expected that the Europeans would have advanced farther than they had, as of mid-1980, with regard to developing a European depot structure. This was still several years down the road.[129] More will be said on this shortly.

Other studies were carried out on common maintenance facilities and common operational software.[130] One interesting feature of F-16 logistics is the spares acquisition program applying to all five countries orders. This involves the procurement by GD of spares covering 125 high-value items at same price as for production orders if the two are placed simultaneously, thereby reducing the price to the air forces. General Dynamics computes the recommended spares levels on these items for all five countries, sends this to the logistics office for evaluation and USAF responds with a determination of the requirement for each country. General Dynamics then processes the orders. This procedure has applied since the first spares buy in January, 1977.

Since the second production buy in July, 1977, the EPI's have had the opportunity to bid on initial spares. The opportunity has also been opened up for the EPI's to bid on a price competitive basis for F-16 material common to other USAF aircraft. The implementation of these arrangements though has been



USAF/General Dynamics F-16A of the 34th Tactical Fighter Squadron is photographed from a Boeing KC-135 tanker during Red Max Alpha exercises. Three aerial refuelings were made by the 12 F-16As during 10-hr., 4,350-mi. nonstop flights.

complicated by several factors. For one, the European air forces were reportedly slow in ordering spares, as well as support equipment. The Europeans were also reluctant to cooperate in supplying the logistics planning data necessary for doing a proper job of planning for support of the aircraft. Another problem was introduced by the MOU's only referring to initial spares, while there was no agreement on what constitutes initial spares and replenishment spares. These problems tended to complicate the task of personnel concerned with logistics in developing a plan for co-production.[131]

Other factors impacting on logistics planning were greater European reliance for periodic maintenance on contractor support (e.g., bases being closer to factories). In addition, there is considerable variation among four European air forces in the level of contractor support desired. As an example Denmark was initially the country most interested in contractor support, having lower projected flying hours for the fighter than the other Europeans, it was willing to accept a slower building up of its own capabilities.[132]

The USAF was reportedly originally concerned that its own resources would come under pressure from commitments to the four EPG's, primarily by draining spares from its inventory if delivery commitments for aircraft and spares orders are not properly in line.[133]

Actually, as of mid-1980, there had been very little direct tapping of European sources for initial and follow-on spares. It is expected that, as it becomes more feasible to bypass General Dynamics, the SPO (and as of the fall of 1980, the Air Logistics Center (ALC) at Hill AFB in Utah, with beginning of Primary Management Responsibility Transfer (PMRT)), will continue to rely

heavily on U.S. vendors, taping the European firms directly in only a few cases. The ALC has gradually been acquiring reprocurement data from the U.S. contractors; first from GD, with that of the U.S. vendors being procured over a longer period of time. By 1981 the program was in the breakout mode on stabilized items.

Most European firms involved in the program are reportedly not all that interested in the investment required to qualify as vendors themselves. Given that there are no guarantees of a long-term business base and that the EPI are not commpetitive with their U.S. counterparts (economies of scale alone accounting for the greater part of this), they have shown considerable reluctance as far as the required capitalization is concerned. Instead they show a marked preference for staying tied to the apron strings of the U.S. vendor to whom they are subcontractors. Evolution away from this pattern is expected to be slow. Most Europeans will stay attached to, and dependent upon, the U.S. partner, because the advance in capability required to quality as vendors or for repair work is too great (e.g., level of testing).[134]

For follow-on spares, AFLC faces no off-set obligations (the MOU off-set requirements applied only to production and initial spares). The EPGs were not interested in paying the concomitant premium for spares. Contracts are awarded by the ALC on a purely competitive basis.

The EPGs originally spoke of going direct to their own firms for certain spares and thereby circumventing the costly USG-US industry loop back to their own industries. (See the later subsection on issue of loadings and GD's reasoning for not going direct to the EPI for spares.) GD's response to this

stance was that the EPGs were welcome to go ahead with this acquisition approach, but then with all parts being GFAE, they would have to assume the concomitant responsibilities. Faced with this prospect, the EPGs backed off.

The first major award directly to one of the EPI was in July, 1982, with the award by the San Antonio Air Logistics Center to Belgium's Fabrique Nationale of a $26,899,610 firm fixed price contract for elements of the F100 engine for Israeli F-15's and Dutch F-16s: 185 first stage disks, 720 forgings for the first stage disk, 130 second stage disks and 1010 forgings for the second stage disk. Two firms had been solicited and two proposals submitted.

The logistics Overview of the Multinational Fighter Program (Enclosure (7) of the DSMC F-16 Lessons Learned Study) identified two factors which significantly complicated the F-16 logistic support program:

- Accelerated F-16 aircraft development and delivery schedule resulted in concurrency (which occurred primarily in the avionics area);
- Unique multinational program arrangements.

The effects of this concurrency on the program include:

- the necessity to plan for at least two years of contractor support at the intermediate level, which impacts the F-16's capability in wartime situations;
- the unfavorable impact on both the delivery schedule and quality of the logistic elements by the late imposition of configuration control to the component level, and;
- test data useful for logistic planning (i.e., estimating spares requirements) would not be available.

Quoting from the DSMC study:

> While the situations described above will exist to some extent in every program, concurrency seems to aggrevate them. Our review of the F-16 indicates some useful approaches to minimizing concurrency impacts. For the avionics, contractor support is being used extensively for CFE and in some areas for GFE. An extensive logistic event milestone network is just now being implemented by F-16 SPO. This network should provide visibility of the "chokepoints." In addition the F-16 has attempted to establish a logistics data file. In a program with a compressed schedule a single data base is a good management control technique.
>
> On the negative side, the approaches just described were implemented late in the program. Also the AIS, a major system from a logistics standpoint was ordered late in the program. The reasons for this appears to be the lack of manpower in the SPO logistic areas.
>
> At the time of the FSD contract only one individual was assigned in the SPO to the logistics area. It was over a year after the FSD contract award before additional personnel were added in the logistics area.[135]

The other major impact on the logistic support for the F-16 can be attributed to the program's multinational character. As a result of this partnership logistic support had to be provided almost simultaneously for seven different base activations: 2 USAF TAC installations; one in each of the EPC's; and one in Iran (replaced by Israel). This is a scenario unlikely to occur under standard FMS agreements. In contrast, during the same initial 18 month period for the USAF F-15, only one base with 67 aircraft (about 1/3 the number of F-16's) was activated in one country (the U.S.).

> But since the number of aircraft was known, and the EPG countries identified, there is little doubt that site activation requirements should have also been known. However, a review of the DSARC II documentation which was the first full scale OSD review of the program indicates that logistics was not mentioned as an issue. There were no experienced logistic personnel involved in the program at that time. This would probably account for the lack of notice in the logistic areas.[136]

This activation of a large number of bases over a short period places unusual demands on both production capacity and available manpower. Orders for the initially large numbers of spares required to outfit each base were placed at a time when the production rate was just building up. The SPO was concerned that production capacity, faced with the rapid build-up in site support, would not be adequate to meet both the end product and spare requiremments. As of spring 1978, evidence had appeared suggesting that there were going to be problems.

In the engine area (a subsystem already in production), it was known that engine spares as backup for factory installation would not be available. The DSMC study noted that,

> One solution to this problem would be for the EPG to agree to share spares. However, national considerations will probably prevent this solution from being implemented.[137]

Manpower was also expected to be a problem in base activations. It was feared that pilots and maintenance manpower would be trained, at a time when there were relatively few assets and everyone was still learning about the system. With many bases involved any problem areas would be magnified.

To compensate for the spares and manpower shortages:

> The F-16 program has instituted a policy of early training and an analytical approach related to aircraft availability to estimate spares requirements. It's too early to tell how effective these approaches will be. However, they cannot overcome the basic problems of production capacity and lack of material resources for training. Given the politics involved in "selling" co-production arrangement, it is probably impossible to improve the situation for

> new programs. The only caution that is suggested is that in selling programs, promises about early support capabilities be minimized.[138]

In July 1980, Lt. Col. Kehl (USAF) of the F-16 SPO was able to report, however, that the severity of spares and manpower problems caused by rapid simultaneous build-up in site support requirements in the six nations have been much less than feared. As such there has been no serious impact on the USAF to date in these areas.

In June, 1978 DSMC study offered the following two logistics lessons provided from the program:

> Logistics consideration will not change the political realities involved in selling a "co-production" program. The approach there is to "minimize the losses." This would involve intensive logistic planning and implementation efforts as early as possible during FSD. In turn, this requires allocation of experienced logisticians and funding (apparently not an F-16 problem) to support the program.
>
> In selling co-production programs, care must be taken about the promises made to other countries in terms of system support. Our experience is that we must mature our support along with the aircraft. Thus, early experience with aircraft is that they have low readiness rates, partially due to hardware and partially due to software. Countries expecting other than this will be "unhappy". Thus, in selling programs the readiness expectation of the country getting the system must not be raised too high.[139]

In August, 1980 a GAO report, "F-16 Integrated Logistics Support: Still Time to Consider Economical Alternatives" (LCS-80-89) was released. Among other things it covered the status of negotiations between the USAF and the four F-16 EPG's over arrangements for European depot level support of the fighter. Per the MOU they were to provide depot support for U.S. F-16's in Europe. This work had been estimated at up to $147 million in offset potential from

1981 through 1986 and may be needed if industrial participation terms of the MOU are to be met, GAO said, but "little if any support" will be available when the F-16 is activated in Europe next year unless the Air Force accelerates its negotiations with the EPG's.[140]

So far, the U.S. and the EPG's "are waiting on each other to make the necessary decisions and commitments", GAO reported. "For example, Air Force officials say they cannot count on EPG's doing depot repair until the EPG's establish and fund the maintenance repair facilities. Yet, the EPG's insist they cannot establish or fund the facilities until they have a U.S. repair commitment to justify their investments."[141]

GAO reported that the EPGs' "senior national representatives" from Denmark, the Netherlands and Norway said "they have no basis to begin planning," due to the following concerns most EPG repair facilities are fully engaged in producing F-16's and won't be able to accept much repair work until production contracts end; that the U.S. limits repair contracts to one year while the Europeans don't; that the Air Force decision permitting repairs by EPG's was made too late for facilities to be ready for 1981, and; that the Air Force was not given the EPG's list of F-16 reparables that would be available for depot repair.

But the fourth EPG, Belgium, said in comments on the GAO's draft report that it would be able to do depot repair work, even during production, according to GAO.[142]

With plans for EPG depot repair lagging, the Air Force "may be overbuying equipment for U.S. repair capabilities", GAO speculated, noting that depot-level avionics test equipment is bought without considering work that may be done by the EPG's. "As a result, the Air Force may have overstated its automatic test equipment requirements by $7 million "[143]

As a sequel to this issue, three years after the release of the GAO report, the French aerospace weekly Air et Cosmos announced in August 1983 that the Belgian firm SABCA had been selected by the USAF as its F-16 depot level maintenance and overhaul contractor in Europe. Fokker had been the competing contractor for this award.

12. GD: SETTING UP FOR TRANSNATIONAL SUBCONTRACT MANAGEMENT

The F-16 production program is a joint business effort to produce the U.S. designed and developed F-16 on both sides of the Atlantic. General Dynamics is F-16 prime contractor with total system responsibility except for the engine, for which Pratt & Whitney is the prime. Both are under contract to the USG which in turn sells the aircraft to the Europeans through FMS channels. Under these two U.S. contractors come all the second and third tier U.S. and European contractors. All production in Europe is second source under contract to the U.S. primes or their subcontractors. There are three aircraft assembly lines, one at GD's Dallas/Fort Worth, Texas facility for the USAF and third country aircraft and two in Europe; one at Fokker in the Netherlands for the Dutch and Norwegian aircraft (originally totaling 178 aircraft), and one at SABCA in Belgium for the Belgian and Danish aircraft (originally 178 aircraft as well). For the engine there are two assembly lines, one at the Pratt & Whitney facility in Florida, and one at Fabrique Nationale in Belgium. Note that in all three cases of European assembly, these firms are acting as subcontractors only, not licensees, the U.S. primes retaining full responsibility.

The ultimate goal of the program is to place enough F-16 production work in Europe to eventually offset 100% of the four European nations' aircraft buy. The 4 LOA's for the 348 aircraft signed in May, 1977, had a collective value of $2.6 billion.

Aircraft and engines manufactured in Europe will be made to U.S. engineering specifications. The drawings and specs provided to the European Participating

Industries (EPI) are in Anglo-Saxon units, and are converted to metric (at their option) and translated to the national languages by the EPI. The drawings are then used to generate the "factory paper" of the EPI, i.e., shop instructions, blueprints, process sheets, etc. Inspection and acceptance are to the original U.S. drawings and specifications in the original non-metric measurements and in the English language.

Thirty odd firms are involved from the four EP countries. Three aircraft firms manufacture airframe components, and assemble the aircraft for delivery to the air forces of the 4 EPG's. Four firms are participating in fabrication and assembly of the engine, and another 27 plus EPI firms are involved with avionics items and equipment subsystems.

Following the signature of the MOU and the preliminary contracts by the four EPG's; GD held a seminar in late July, 1975, in Fort Worth to explain to its U.S. subcontractors the ground rules for European coproduction. The subcontractors were instructed to offer standard DoD purchase order contracts and standard request for proposal forms.

In late October, GD organized a trip to the four EP countries for 40-odd existing and competing U.S. subcontractors. The group's first stop was in Copenhagen. After the U.S. teams presentation at a meeting sponsored by the Federated Danish Industries, the participants broke up into splinter groups representing specialty areas. With 50 Danish firms represented, only 12 stayed around for detailed briefings, and only two of these employed more than 500 people.

The next stop was Oslo, where the U.S. industrial team was informed that the Norwegian government would select those Norwegian firms that could participate in coproduction. According to Norman Day, GD's F-16 Director of Material, "Later this gave us problems because the Norwegian government didn't want too many companies dependent on defense contracts.[144]

The team then moved on to The Hague and Brussels where they found experienced aerospace companies.

GD left its U.S. subcontractors in Europe and instructed them to issue RFP's on the spot, and to come back to GD with firm proposals by the spring of 1976. But this was not to be. By July, 1976, there had only been two major coproduction awards. Both were by GD itself; one being to Fokker in the Netherlands, and the other to Fairey (soon to become SONACA) in Belgium.

The first problem, according to Day, was that the prospective EPI "couldn't understand U.S. armed services procurement regulations. We extracted complete sections and translated them into (simple) English.[145]

Once this was accomplished another problem cropped up.

> The Europeans soon found that they had a lot to learn about the arcane ways of American military procurement. General Dynamics had to put into its overseas contracts the Pentagon's standard boilerplate clauses, including the right to terminate all work, that are ordinarily in American defense contracts. The Europeans went crazy. They absolutely refused to sign. Many of the contract terms went against the grain of European business practices, while some clauses imposed 'unwelcome' U.S. government supervision. Most of all, the very notion of having to conform to alien ways riled European executives.[146]

The 'unwelcome' supervision included the aforementioned USG accounting and auditing requirements. Quoting from the March 1977 issue of Fortune magazine:

> All together, General Dynamics ran into varying degrees of resistance to several dozen conditions. Scheideman, who still flushes when recalling the struggle, insists: "We never doubted that they could make the parts. The real question was, could they do business like a normal U.S. aerospace organization?" To resolve the impasse, General Dynamics called for Washington's help. "It was clear", says Scheideman, "that the U.S. government couldn't just make this famous offer and then walk out of town."
>
> The company enlisted the help of Fred Wood, the Air Force's business director for the F-16. A senior civil servant with exceptional flexibility, Wood recognizes that the Europeans are motivated by one basic principle: "There must be something in it for them." Nonetheless, it took Wood and General Dynamics officials nine months of haggling with five governments and dozens of companies to settle everything.
>
> Some of the most distasteful contract terms have been made palatable by compromises that, in retrospect, seem amazingly simple. But the U.S. government had to surrender some of its usual prerogatives.[147]

Other business differences encountered included financial practices. Even though the U.S. contractors were offering straight, fixed-price contracts, U.S. and European financial practices were not compatible. As examples of this Blaine Scheideman, GD vice president and director of the F-16 international program, pointed out that, in Europe, depreciation is at replacement value, not book value as in the U.S. As another example, imputed interest is allowable as an expense in Europe, whereas it wasn't at that time in the U.S. Also, the 100% scheduled payment issue arose frequently. Other problems that cropped up will be covered shortly.

In addition to a need for a greater display of flexibility on the part of the U.S. government agencies, much of the problem was due to a wide variance

between the U.S. and European firms in the amount of their experience in dealing with international collaboration in defense programs. Many of the European firms have been involved in such programs for years (e.g., having a complete file of U.S. Mil-specs and Standards, and having worked with most of them), while U.S. firms have been involved to a significantly lesser degree. This is especially true of the winning U.S. prime contractor team. Whereas the losing Northrop and General Electric team represented two of the most experienced U.S. firms in this area, the opposite could be said of GD and Pratt & Whitney. In the words of General Abrahamson, F-16 Program Manager:

> Initial contracts with European industry suffered owing to this lack of experience and the "not invented here" approach taken in dealing with European industry leaders. United States Government agencies suffered from this same lack of international experience the lack of sensitivity to European concerns and issues, and a tendency to deal with the European Air Forces/Governments on the basis that the U.S. way was the only way. Change is this attitude, which is not yet complete, has been a difficult process.[148]

Thus we see that, though the technology flow was in one direction, there was room simultaneously for a great deal of collaborative, and some technical know-how to be transferred in the opposite direction. Two of the more prominent cases involved Fabrique Nationale (FN) and Fokker, both of which had been heavily involved in numerous earlier collaborative programs treated elsewhere in this paper. Citing the May 2, 1977 issue of Aviation Week & Space Technology:

> Jean de Fonvent, director of FN's engine division said: "We think we have been able to be of some help to Pratt & Whitney with the communications lessons we learned at FN in previous international programs." Fokker concurs with the FN position. Van Bijleveld said: "On the managerial side the management of multinational projects is nothing new to us. General Dynamics had a lot to learn

here. In this respect, it has been a two-way street." He credited General Dynamics, however, for having made "tremendous strides in working with Europe."

Fokker officials said they had been told by General Dynamics that the Fokker final assembly concept had heavily influenced General Dynamics' own final assembly procedures. Additionally, according to the Dutch company, Fokker technicians were able to exchange experiences with General Dynamics in honeycomb construction. Both are using different techniques to get the same results in flaperons and wing leading edge flaps.[149]

Fokker had to open GD's eyes as well, to other realities of international industrial colloboration. As one of the world's oldest aircraft manufacturers, and the only one in the Netherlands, the bulk of the Dutch work inevitably fell to Fokker.

But to General Dynamics' dismay, Fokker is spreading its portion of F-16 parts and assembly among six widely scattered plants. This arrangement threatens to be considerably more cumbersome than the easy assembly of the fighter in the mile-long Fort Worth plant. The F-16 is bulit in sausage-like sections, each of which is stuffed with wires and electronic boxes; then the sections are simply bolted together and connected. In the Netherlands the sausages are going to travel a lot. But that happens to be the way that Fokker is organized, and the Dutch government also wants to spread the jobs around. These larger realities are so obvious to Fokker that its manager of manufacturing engineering, Theo Van Bijleveld, remarks: "General Dynamics was an absolute newcomer here, and they are still learning."[150]

Another area where GD was rudely surprised concerned the European industrial relations environment and its impact on cost and production schedules. This will be treated shortly.

In any event, quoting the Fortune article by Krarr,

> In fairness to the American company, it should be pointed out that the European manufacturers were not terribly willing to educate General Dynamics or to negotiate details, until their governments had actually selected the F-16. Lewis's men had to estimate the costs of making the plane abroad before they fully grasped how European manufacturers operate. "And that may have been a mistake", he concedes. Only when the European companies started bidding on their shares of the F-16 did General Dynamics finally realize that the lead times would be longer and the costs higher than expected.[151]

On the U.S. government side two projects were cited several years later by Col. Ron Carlberg as having been studied for useful precedents during the early phases of project. The first one was the recently completed German F-4 coproduction program wherein German industry received offsetting subcontracts from U.S. contractors for the Luftwaffe's initial order of 88 F-4's (see Chapter 11). The second, the on-going NATO Seasparrow project was studied later, but only after they had gotten over to Europe and had found that the NATO Naval SAM system project was constantly being cited by the four EPG's and EPI's (see Chapter 10).

13. GD's International Program Management Effort

a. Program Management

Within General Dynamics F-16 program at Ft. Worth, Texas, as of 1977, there was a consortium program office with a staff of four country managers; one for each of the four EPC's. Following daily 8 a.m. meetings covering F-16 program status, the director of the consortium program holds a daily 11 a.m. meeting of his staff and the dedicated line organization consortium program personnel to review status charts in detail and cover all open items. The status charts are updated by data from similar charts in the Brussels office, which in turn are updated by data from charts at each of the in-country resident offices.[152]

GD's Ft. Worth consortium program office has a counterpart European program office ~~in~~ Brussels. The Brussels office includes two directors, one for production and the other for customer support. The production director oversees a staff of specialists representing plans and control, engineering, material, production, and quality assurance, each maintaining contact with line organization counterparts in Ft. Worth. Under the director customer support comes four country managers.

The Brussels office also maintains resident offices at a major supplier's plant in each of the four EPC's (e.g., SONOCA/SABCA in Belgium and Fokker in the Netherlands).[153]



Le F-16 : un modèle de perfection en matière de performances d'avions de combat.

Les pilotes qui ont été opposés à un F-16 Falcon sont les premiers à dire qu'il est de loin le meilleur avion de combat air-air au monde. Même lourdement chargé de bombes, le F-16 dispose de la puissance et de la manœuvrabilité nécessaires pour prendre le combat chez l'ennemi et en revenir.

GENERAL DYNAMICS

Communications flow from the resident offices to Brussels, covering program status in each of the countries or seeking solutions to problems. If the problems cannot be solved by the Brussels organization, the specialist in engineering for example, will contact his line organization counterpart in Ft. Worth.[154]

Copies of these communications come to the office of GD's consortium program director in Ft. Worth, so the status of all requests, responses and action can be tracked. This office can also alert other interested groups in the plant to a problem. The response time goal is 24 hours. The greater part of requests are handled in that time. If it can't be done in that time, the representative at the European resident office gets a stated response time, thus providing a check-and-balance. The consortium program director's office maintains a status of open items and can apply attention to the line organization to get the problems cleaned up.[155]

The communications system between Ft. Worth and Brussels includes telephone, Telex, teletypewriter, facsimile transmission and a weekly mail pouch. The pouch leaves Ft. Worth every Friday morning annd arrives in Brussels the following Monday. Brussels sends Ft. Worth a pouch every Tuesday, arriving here on Thursday morning.[156]

b. Transnational Subcontract Management

The three principal subcontractors of GD in the EPC's were the Dutch firm Fokker and two Belgian firms Societe Anonyme Belge de Constructions Aeronautique (SABCA) and Societe Nationale de Constructions Aeronautique (SONACA).

Fokker is one of the world's oldest airframe manufacturers. Since WWII in addition to civil aircraft of its own design (principal among these being the F-27 and F-28 transports), Fokker has participated in the production under license during the 50's of the British Meteor and the Hawker Hunter fighters, the Lockheed F-104G in the early 60's and the Northrop F-5 in the early 70's.

SABCA had handled the production of the wings and the assembly of the F-104G's in the early 60's and produced wings for the Dassault Mirage 5 during the 70's. As such it was natural that GD gave SABCA wing production and final assembly for the F-16. SONACA, which had produced the aft fuselage for both the F-104G and the Mirage 5, received this same part of the F-16.

Most other EPI contracts did not involve GD directly. GD's US suppliers were held responsible for selecting and managing their own subcontractors in the EPC's, as will be covered shortly.

Each of the European assembly lines has been producing three aircraft per month in comparison to the US line where GD was building up to a 15 aircraft per month rate. SABCA and SONACA are collocated at Gosselies in southern Belgium on opposite sides of the same airfield and will assemble 174 aircraft

	European Manufacturer				US Manufacturer
	Belgium	Denmark	The Netherlands	Norway	
Structure					
Center Fuselage			Fokker-VFW		General Dynamics
Aft Fuselage	Sonaca				General Dynamics
Wing Box	Sabca				General Dynamics
Leading Edge Flap			Fokker-VFW		AiResearch
Flaperons		Jorgen-Hoyer	Fokker-VFW		General Dynamics
Vertical Fin		Per Udsen			General Dynamics
Pylons		Per Udsen			General Dynamics
370 Gallon Tank				Nordisk	
Landing Gear			DAF		Menasco Manufacturin
Assy Fin Box	Sonaca				General Dynamics
A/C Assembly + Fly out	Sonaca + Sabca		Fokker-VFW		General Dynamics
Main Wheels				Raufoss	
Engine					
Fan, Core, + Assy	FN				Pratt & Whitney
Gear Box Module		Disa			Pratt & Whitney
Augmentor Module			Philips		Pratt & Whitney
Fan Drive Module				Kongsberg	Pratt & Whitney
Engine Assy	FN				Pratt & Whitney
Equipment					
Servo Acuators	Sabca				Nat. Water Lift
Emergency Power Unit		Disa			AiResearch
Engine Starting System		Disa			Sundstrand
Heat Exchanges		Quintzau			Hamilton Standard
Inverter		Silcon			Aerospace Avionics
Manual Trim Panel		Standard Electric A/S			Gen. Dynamics
Pneumatic Sensor		Burmeister & Wain			Rosemount
Door Actuator		Disa			Arkwin
Fuel Quty Measure			Simmonds		Simmonds
Accelerometers				Kongsberg	Systron Donner
Ammunition Handling System				Raufoss, Norcem	General Electric Sperry Vickers
Anti Skid Brakes				Kongsberg	Goodyear
Radar Racks				NERA	Westinghouse
Wheel				Raufoss	Goodyear
Avionics					
Radar Computer	MBLE				Westinghouse
Chaff + Flare Dispenser		Disa			Tracor
Channel Frequency Indicator		Radartronic			Magnavox
Electric Component Assembly		Standard Electric			General Dynamics
Flight Control Computer		Burmeister & Wain			Lear-Siegler
Flight Control Panel		Standard Electric			General Dynamics
Fire Control Computer		DIG-1/ Rovsing & Neselco Burmeister & Wain DIG I			Delco Electronics
Radar Control Panel		Burmeister & Wain			Westinghouse
Radar E/O		NEA-Lindberg			Kaiser
Head Up Display			Oldelft	Kongsberg	Marconi*
Radar Antenna			HSA		Westinghouse
IFF Transponder				STK	Teledyne
Central Air Data Computer				STK	Sperry
Inertial Navigation Set				Kongsberg	Kearfott Singer
Interference Blanker				G.A. Ring	Novatronics
Rate Gyros				Kongsberg	Northrop
Stores Management Set				Kongsberg	General Dynamics

* Marconi Elliot is the only UK manufacturer in the F-16 program.

Source: NATO's Fifteen Nations

for Belgian and Danish air forces. Fokker will assemble the aircraft for the original combined Dutch and Norwegian requirement of 174 aircraft.

Under an agreement with the three European subcontractors GD/Fort Worth is handling "umbrella" procurements of material. The combined purchases for itself and its subcontractors allow the firms to take advantage of better prices for large volume procurements of such raw material as sheet and plate aluminum stock.

Though initial shipments for long-lead procurement were made to Ft. Worth and then trans-shipped to Europe, these "umbrella" purchases have since been made by the European firms themselves. The European subcontractors coordinate with GD for these purchases, with the raw material destined for them being shipped directly to their factories.

GD provided early airframe production support to its European subcontractors including:

1. One disassembled F-16 each to Fokker and SABCA/SONACA.

2. Six aft and center fuselages and six vertical fins to SONACA, and three of each to Fokker.

3. 30 ship sets of details and assemblies, including center fuselages, main landing gear doors, main landing gear build-up, wing leading edge flaps,

wing trailing edge panels and flaperons, three ship sets of center fuselage components and other assembly details to Fokker.

4. 15 ship sets of aft fuselages and other assembly details to SONACA.

5. Two ship sets of wing box structure and other details to SABCA.

6. Six ship sets of vertical fin details to Per Udsen.

7. Five ship sets of vertical fin details to SONACA.[157]

Some of the material is to be "paid back" by the European airframe coproducers late in the coproduction program. The repayment is to include 11 ship sets of center fuselage, aft fuselage and vertical fins and two ship sets of main landing-gear doors, leading edge flaps, flaperons, wing trailing edges and wing box structure.[158]

There are more than 3,000 suppliers and subcontractors involved in the program on both sides of the Atlantic, and synchronizing their efforts becomes critical to the outcome of the program. "The whole problem as we see it is management of materials," Day said. For the basic 998-aircraft program, he pointed out that 3 million individual items and 20 million lb. of raw material would cross the Atlantic.[159]

Early-on in the program, GD found itself being snowed by the Europeans with requests for special drawing data, such as brownlines and aperture cards. The

program got bogged down with the distribution and control of so much data. General Dynamics finally went back to giving the Europeans the same drawing data that they gave to their own manufacturing. This reportedly solved the problem.

Another point worthy of note stems from the fact that Eruopean countries build to drawings, not to planning papers. In fact this provided the best drawing audit General Dynamics ever had. General Dynamics received 1488 requests for changes in the first six months. 448 required ECN's out of which 350 were drawing corrections. Liaison changes are authorized by Tech. Reps. "on site", but all changes come back to General Dynamics for accountability.

After experiencing problems with documentation, packaging and packing of high value defective items, General Dynamics proceeded to correct the situation. There are some cases of confusion surfacing over items that had been returned by the EPI's which were simply "tossed into a box" without proper packaging, packing, or documentation to identify the problem, defect, or method of testing. This caused damage to the items, confusion as to the reason for return, and items not being reordered to fill the void of the returned items. Burchfield's recommendations on this point were:

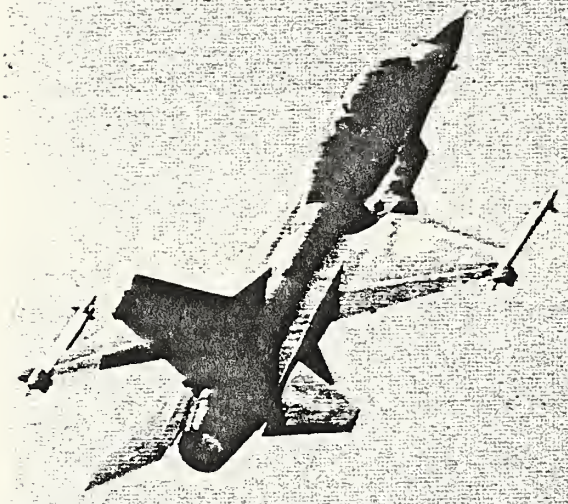
> Future programs should require some type of documentation system for defective or damaged items, orientation of instructions on proper packaging/packing and shipping, and indoctrination on reordering methods to prevent shortages which may result in delays in production. This problem will require training and in depth (detail) instructions from the prime contractor which General Dynamics has done as a result of their experience.[160]

GD has been successful in fulfilling a program goal of the transfer of significant technology to its European subcontractors. This has included for Fokker and SABCA experience in systems integration and final assembly in such areas as flight controls that both firms expect to be able to use on future civil aircraft programs.

The technology transferred to the three firms involved in final assembly and flight testing is described as "substantial", which is stated to mean over 50 percent increase in the company's ability to produce the products. Technologies not transferred include composite fabrication and aluminum powder metallurgy.[161]

Sonaca, which manufactures the aft fuselage and parts of the vertical fin plus carries out the fuselage mating operation, provides a number of specific examples of technology transfer. As a result of the F-16 program, according to the USAF, the company has acquired several new technologies or facilities including:

- Three new 5-axis numerically controlled machines;
- New post stretch draw and chemical milling capability;
- An updated heat treatment facility;
- A controlled paint facility;
- Integral fuel tank sealing techniques;
- Fixtures, tooling and test equipment;
- Quality assurance;



The Dutch Connection

For U.S. F-16 Co-Suppliers in Europe

Simmonds Precision, a member of the co-production team, has established a F-16 Product Support Center in Brummen, Holland, which handles repair, overhaul and inventory services.

That same service is now available for *your* F-16 systems and components.

General Dynamics has designated Simmonds Precision as the European Support Center not only for our products, but for F-16 pneumatic, hydraulic and electro-mechanical devices manufactured by other U.S. co-producers.

Our new center now provides expanded and integrated logistics support services including:

- Spare Parts Provisioning
- Emergency Spares Service
- Field Service Engineering
- Contract Repair and Overhaul
- Training and Documentation

Simmonds Precision's F-16 European Support Center can reduce your response time and cut shipping costs.

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Tel: 05756-7777 Telex: 49097 Simpre NL

Simmonds Precision

Circle Number 97 for Reader Service Card

- Manufacturing planning and control; and
- the know-how for modular assembly.[162]

SABCA, on the other side of the Gosselies runway, is responsible for the wing box, final assembly and flight testing operations. Fokker in the Netherlands is responsible for the central fuselage, flaperons, leading edge flaps, fuselage mate, final assembly and flight operations. Both companies are said to have benefitted from several of the operations listed above at Sonaca. For example the F-16 program involved Fokker's first time using five-axis numerically-controlled machine tools in high volume operations.[163]

The transfer of technology was generally based on whether it was cost-effective for the European company to acquire the necessary capability. In some cases, particularly where smaller companies lacked a given capability, it was not worthwhile for them to acquire a skill with limited potential for future production.[164]

As another example, General Dynamics manufactures the entire forward fuselage for all aircraft in the U.S. since there were more changes in this part than any other. With a single manufacturer it was easier and cheaper to react to changes.[165]

GD also faced problems in placing work on composite materials with the EPI. Fokker had been expecting to produce landing gear doors of carbon fiber, but as an economizing effort, GD reverted to standard sheet metal for the doors. In GD's attempt to place composite work in Denmark, three Danish firms tried

it and dropped out on their own. The firms weren't anywhere near competitive with the experienced U.S. firms and the investment required would have been much higher than the value of work available on the F-16 program could justify.

Summarizing the benefits to the European companies in technology transfer, the USAF position was that they have acquired better production and production-rate techniques as a result of participating in the F-16 program. They have acquired new technology, business and management methods and broadened their business bases. Major mutual benefits to the four countries and to the United States include closer international partnership, a step towards improving NATO rationalization, standardization and interoperability, and increased sales.

14. GD's U.S. Suppliers and Their Second Tier European Subcontract Efforts

Twenty eight U.S. suppliers of GD were handed the resonsibility for selecting and managing their own suppliers in Europe. Whereas an original total of only 174 European aircraft was to be assembled at each of the two European assembly lines, most participating European manufacturers were producing components from the beginning on the basis of 998 aircraft (650 U.S. and 348 EPG).

a. Westinghouse

Each EPG wanted its appropriate share of production of high technology elements of the system - particularly the Westinghouse radar - while still not significantly contributing to an increase in the cost of the aircraft. Westinghouse had devised a system of six separate electronic boxes that could be divided readily among subcontractors. However, due to the developmental stage which the radar program was at, and the originally uneconomical quantities of those items to be built in Europe, Westinghouse was unable to bring European prices down to an acceptable level. The bids of some Belgian companies were as much as 50 percent higher than Westinghouse's prices. Since the multinational agreement requires European coproducers to be "reasonably competitive" in price, several Belgian companies' bids were rejected, causing an irritating embarrassment to their goverrment.

To make matters worse, by the Fall of 1976, when many of the coproduction arrangements had been sown up, Norway and Denmark were complaining that their industry

was being short changed, and so Westinghouse found itself obligated to make up work distribution short-falls in other parts of the program. Therefore, by late 1976, with production lead time constraints rapidly closing in, it was apparent that Westinghouse would have to place larger quantities of fewer items with fewer European companies (while still maintaining at least some in-house production of all elements). Belgium was the government that had to bite the bullet, dropping two of its three prospective firms (one of which was Westinghouse's own Belgian affiliate in that country, ACEC).

The Geddes article in the November 1979 issue of Interavia singled out two of Westinghouse's three EPI subcontractors as examples of the high level of technology transferred.

MBLE of Belgium, which makes the Westinghouse radar computer, acquired the Hewlett Packard 9500 automated test capability, an industry standard for integrated circuits in the U.S. Other benefits to the company are said to include Westinghouse automatic test equipment, production control and configuration control, meriting the label "substantial" for the value of the transfer. Technology not transferred to MBLE and others included the manufacture of multilayer printed circuit boards and integrated circuits.[166]

Even manufacturers such as Hollandse Signaalapparaten of the Netherlands are thought to have benefited from techniques such as numerical control machining and brazing; automatic RF test range procedures and equipment; acceptance test procedures and equipment; configuration control and quality assurance. It was said by the USAF, specifically of Signaal, that their version of the Westinghouse radar antenna is superior to the unit made in the United States.[167]

b. Marconi-Elliott Avionics

One major European firm participating in the F-16 program falls into a category separate from the others in that its participation was not a consequence of the consortiumm purchase decision. The UK's Marconi-Elliott Avionics designed and produces the head up display (HUD) for the F-16. Marconi is listed as a U.S. subcontractor and is not a second source as with the EPI's.

Marconi-Elliott brought to the program its previous experience with the Anglo-German-Italian Tornado multi-role combat aircraft (MRCA) which taught the firm, among other things, to keep the number of people in the control loop low. As a result it has structured its F-16 EPG subcontracting work so that each single unit is built in one nation, eliminating the situation where parts and pieces from various nations have to be integrated into a unit.

As part of the U.S. offset effort, Marconi signed subcontracts with two EPI firms in mid-1976; Kongsberg Vapenfabrikk of Norway and Oldelft of the Netherlands. The two firms work from Marconi-Elliott drawings and data sheets, and are responsible for their own procurement and materials sources. In contrast to the situation between GD and its EPI subcontractors, Marconi assumed responsibility for translation and converting measurements on drawings.[168]

c. Menasco

Some North American subcontractors of GD were forced to create their own potential competitors. Menasco Manufacturing Co., for example, found that no company

in the four NATO countries is a specialist in landing gears. Menasco therefore had to teach DAF, a Dutch truck manufacturer, how to make landing gear components. DAF started with an injection of Menasco's know-how and a $26.3-million order, which represented half of Menasco's own piece of the fighter as of that time. The manager of DAF's special projects division Peter Hothuizen felt, "This opened the way for DAF to make landing gears for other planes in the future."

Bearing out this optimism, DAF was willing to put up a new factory wing and invested $6 million in production equipment. Though DAF turns out components for German military armored vehicles (see Chapter 11), it is not nearly as exacting as the F-16 work. "The Germans send us a big package of drawings and if there are any problems, we communicate", says Holthuizen. But landing gears are such a crucial part of the fighter that Menasco will base six technicians in the Dutch plant.[169]

DAF is also among the cases that the USAF has used as an example of introducing new technology and capability into the EPI. DAF acquired capabilities in numerical controlled machining; fabrication techniques with new alloys; anodizing; titanium-cadmium/chrome/nickel plating; heat treating; manufacturing control and quality assurance. The measure of transfer gets the rating "maximum". It is probable that DAF will compete for new landing gear contracts for years to come.[170]

d. Hamilton Standard

Like other U.S. subcontractors, the Hamilton Standard division of United Technologies had to bear all the expenses of finding a coproducer for heat exchangers.

In Sonderborg, Denmark, it discovered Quitzau which had never made aerospace gear, but its skills were close enough to win a $4-million contract and Hamilton Standard's production technology.

Quitzau, which has limited capital, is renting a $120,000 vacuum braising oven, which is made in the U.S., so that it can do the F-16 job. This arrangement exemplifies the fact that a substantial portion of the money going into Europe actually comes back to the U.S. to pay for raw materials and production equipment. But for the Europeans, the coproduction contracts represent a technical step upward and the probability of American orders for years to come.[171]

e. The Case of Danish Industry

It is in the area of avionics that Denmark, which has the lowest offset return in dollars and jobs, is said to have done well. This covered a wide range of subsystem and component technology transferred. B&W Electronics builds the Lear-Siegler flight control computer, the Westinghouse radar control panel, the Rosemount pneumatic sensor assembly and ice detector. The measure of technology transfer on the last two items is rated "low" by the USAF, but the computer and radar panel are thought to provide a substandial transfer. New technologies or capabilities gained by B&W include manufacturing, planning and

control; printed circuit board cleaning procedures; flow soldering; controlled paint facility; tooling and test equipment; multilayer board assembly; production procedures; and quality assurance.[172]

f. Lower Tier Procurement by the EPI in the U.S.

All the integrated circuits and many other components used by the European suppliers are made in the U.S., primarily because there are very few companies, even there, with the capability or desire to build to military specifications. Philips in the Netherlands had the capability but not the military qualification. The company was given the choice of qualifying or buying integrated circuits and chose to buy, presumably on the grounds that the investment required to qualify was not worth the return. Many of the multilayer printed circuit boards are also imported even though European boards are said to be as good as American ones.[173]

15. Pratt & Whitney's European Subcontract Effort

The Pratt & Whitney F100 engine for the F-16 was already in production when the F-16 airframe entered engineering development since it is the same engine used on the earlier (and more sophisticated) F-15 fighter. This naturally made its task easier than that of GD or Westinghouse. After surveying 40 firms from among the EPI's, Pratt & Whitney selected one from each EPC:

Country	Firm	Contract[174] Value	Work
Belgium	Fabrique Nationale	$836M	inlet and fan module, core engine module, and engine assembly and test
The Netherlands	N. V. Philips	$142M	after burner, and exhaust nozzle module
Denmark	DISA	$38M	main gearbox module
Norway	KV	$163M	fan-drive low-pressure turbine and shaft module

The modular design of the F100 engine, intended to facilitate maintenance and to reduce the number of spare engines required is advantageous as well for joint production.[175]

P&W selected its four EPI subcontractors, and assigned work, on the basis of their capabilities. Early in the offset negotiations Pratt & Whitney informed the EPG's that there was no efficient way engine work could be distributed proportionally among the 4 EPI's. So, as it turned out, Belgium's Fabrique Nationale (FN) alone received around 71% of the engine work and contributed in

good part to Belgium's disporportionately large share of total F-16 program work placed with the EPI's. The engine work in turn accounts for around half of all Belgian work. FN had been heavily involved in the license production of engines for such earlier collaborative projects as the Rolls Royce Tyne engine for both the Atlantic Maritime Patrol Aircraft (Chapter 5) and Transall C-160 military transport (Chapter 8) projects, and the General Electric J79 engine for the F-104G fighter (Chapter 7).[176]

Even though the European assembly line for engines is at FN, each of the four EPI subcontractors are individually responsible to P&W directly. P&W in turn, is responsible to the U.S. Government who provides the engines to GD as government furnished equipment (GFE).

Initial P&W preparations for European production of the F100 were completed by mid-1977 and included:

- converting the dimensions on drawings—dual English/metric dimensioning was used;
- translating the labels on drawings into French, Dutch, Danish and Norwegian;
- translation of operation sheets;
- tooling layout, and;
- training of some of the European workers.

FN is moving into F100 production in three phases, manufacturing more of the engine components itself in each phase.

The first FN produced engine under Phase 1 was scheduled for completion in September, 1978, after having been run in June, torn down and inspected, reassembled and run again. This cautious approach was to continue for several years until the confidence level had been built up. The first complete engine under Phase 2 was due in February 1979, and under Phase 3 for January 1980. FN production of F100's for the EPG F-16's was to rise to a maximum of 8 per month by August 1980, and decline to 5 per month in late 1983 with the last scheduled for November, 1984.

Those components FN is not manufacturing will be supplied by either P&W or the other three EPI engine participants. The four EPI's collectively were guaranteed a nominal offset of about 43% of the value of the 438 F100 engines for the 348 EPG F-16's. In actuality though the EPI subcontractors are allowed their own make-or-buy decisions for their components, according to the amount of capital investment they believe it prudent to make. Consequently the four EPI engine subcontractors will collectively produce only about 25% of the value of the 438 engines. In line with the overall program offset, however, the EPI's will get 10% of the value of the F100's produced for the USAF's 650 F-16's and 15% of third country sales.[177]

The EPI's building of parts sets for the USAF F-16 F100 engines will rise to a maximum of 9 per month in 1981, and end in early 1983 when the last of the initial USAF buy of F-16's rolls off the line.

P&W's contracts with the four European firms are fixed-price with inflation escalator provisions.

> This type was chosen as the simplest way to bridge the gap between the accounting systems used in Europe and the one used by Pratt & Whitney. The Europeans did not want to change their accounting systems to track costs all the way through, as would be required for cost-plus-fee contracts. Also, European companies generally tend to be more reluctant to part with financial data than are U.S. firms.[179]

Pratt & Whitney was satisfied with capital investments of the 4 EPI subcontractors. All four of P&W's EPI subcontractors gained new technological capabilities from the program. In 1977 Lawrence W. Clarkson, P&W's vice president for the consortium program cited as examples of this, the materials, tolerances and manufacturing controls which involved new manufacturing techniques for the Europeans. Fabrique Nationale is receiving significant experience in high volume operations with titanium and nickel alloys, and manufacturing to the higher temperature and pressure ratios at which the engine is built to operate._ DISA, with the experience it was gaining in the production of gearbox modules, was expected to create the potential for a new product line, there being nothing comparable available elsewhere in Europe.[178]

FN not only assembles and tests the F100 engine but has a major share of what engine related manufacturing there is in the EPI. FN manufactures the engine inlet fan module and the engine core module, after which it asembles and tests the complete unit. A substantial level of technology was transferred to this company including titanium welding and grinding; Pratt & Whitney's pack coating and flame spray process; Inconel 100 machining; stator bronzing; electric discharge machining; broaching; production control; fixtures, tooling and test equipment; and the company acquiried a new engine test facility. Technology not transferred to FN included directional solidification; gatorizing; and investment casting.

The transfer of certain advanced technologies to the Europeans, however, is being restricted by the U.S. Air Force for security reasons and by Pratt & Whitney to protect proprietary data and know how. Foremost among these are the Nickel-based superalloy blades for the two-stage high-pressure turbine which are made from directionally-solidified investment castings. Directional solidification is a state-of-the-art Pratt & Whitney patented technique for longitudinally aligning the metal grains by gradual withdrawal of a casting from a furnace. Pratt & Whitney supplies the directionally solidified turbine blade castings to Fabrique Nationale, which then performs the detailed machining.[179]

Another restricted technology is an isothermal pressing technique for superalloy powder to form superalloy billets of materials such as TN 10 nickel alloy that are virtually unforgeable. P&W supplies gatorized turbine disk billets to its European partners for machining.

As only a small number of components for the F100 engine are actually manufactured in Europe there were a number of complaints from European companies. Several companies had an opportunity to do more, and one possible reason why they did not was offered by in November 1979 Interavia article as caused by the way in which Pratt & Whitney presented the program to the European suppliers. This is said to have created a negative outlook on fabrication, which is now regretted.[180]

As an example, the Dutch firm, Philips, was cited. Philips has a reputation as a high-quality, very experienced electronics company; yet out of the 120

parts in the engine augmentor module (afterburner), the company chose to build only 18. Of these 18, some have high technology in them. Pratt & Whitney buys most of these parts and it is possible that it was too expensive for Philips to acquire the technology. Among the new technologies or capabilities that Philips is stated to have acquired by building the augmentor are titanium and waspalloy welding, titanium machining and Pratt & Whitney's flame-spray process. The measure of transfer of technology is described as "minimum", which speaks for itself. Technology not transferred includes titanium hot forming.[181]

As with General Dynamics, P&W was also responsible for updating management systems for its European subcontractors, an example of which is the computerized on-line, real-time job-control material-flow scheduling system being developed with Fabrique Nationale. Data from the computer at FN's Herstal plant is transmitted to the P&W's office in Brussels and then via satellite link to Pratt & Whitney's Manufacturing Division in East Hartford, Connecticut. This permits the managers in Each Hartford to know where all the components are and their state of fabrication as they pass through the Belgian shops, from raw materials inventory to finished goods inventory, where the first Belgian-made F100 parts have arrived. The same is done with the assembly process. Similarly, data from Fabrique Nationale's engine test cells is linked to East Hartford and then to West Palm Beach for monitoring by the engineers.[182]

Also, to keep the U.S. and European F100 management in step, there are identical "command posts"—planning/chart rooms—in West Palm Beach and in the F100 office in Brussels. The actual planning work is done in Brussels, and the changes are sent by teleprinter to West Palm Beach to update the charts there.[183]

Coordination is further ensured by Pratt & Whitney's stationing of people at the other three European subcontractors plants to track scheduling and manfacturing control. Altogether, P&W had about 30 people in Europe for the F100 program (as of mid-1977)—including 12 in Brussels and 13 at Fabrique Nationale, and planned to add a dozen more quality control experts by the end of 1977.[184]

Additional Pratt & Whitney personnel shuttle to Europe for special short-term tasks on United Technologies' corporate 727.[185]

In December, 1980, the first and only case of termination for default of a major European subcontractor for the F-16 Multinational Fighter program occurred. Pratt & Whitney terminated its $25 million contract with Dansk Industri Syndikat (DISA) for the production of accessory drive gearbox modules for the F100 engine after the company failed to meet revised delivery and cost schedules. Reasons cited in Aerospace Daily by Pratt & Whitney's David Hymer, director for Multinational Programs, for the termination was that the company was unable to meet schedule requirements for the F100 engine. There was also a cost issue, Hymer said. DISA "was, in fact, losing money on the program". Hymer said P&W wasn't happy about terminating the agreement. "We tried for the better part of a year to salvage it", offering "a great deal of technical assistance", but to continue "would not be fair" to buyers of the F-16.[186]

As DISA's problems continued, "our obligation under the contract diminished", Hymer was quoted as saying, and eventually "it became evident that we had reached the point where decisive action was required", so the agreement was ended.[187]

DISA had been having difficulties with its contract almost from the beginning of the program. Most of the other European countries involved in the project had had problems too, but they began disappearing in about 1978. DISA's didn't. As a result, says Hymer, it was the only company "that has not been effective or efficient" in its F100 work.[188]

"The reasons, perhaps, are many", he said. Among them are the fact that the product itself is demanding and "requires the proper management and support". DISA "didn't do either very well". It had been picked in the first place on the same basis as all the other F-16 subcontractors, being judged as capable of meeting its contract.[189]

Problems first began to surface according to another source, when DISA selected a less expensive and more versatile gear cutting machine than the highly specialized one recommended by P&W. A high rejection rate ensued and DISA found itself having to buy gears from P&W at a premium to cover the shortages.[190]

The Danish company said contract termination would lead to layoffs of about 100 workers. Cancellation of the DISA gearbox contract came at a time when the Danish media and Parliament were screaming about the skyrocketing costs for Danish participation in the F-16 coproduction program and the country's having received the short end of the stick in offsetting contracts.[191]

Inflation and rising dollar exchange rates had increased the price of the F-16 by about 28% in the previous year alone.

Certain Danish politicians were once again charging that the U.S. had failed to live up to the intent of the agreement to provide compensating work to Danish industry in line with that of the other EPI's. Although the issue was several years old by then, the weakening of the Krona vis-a-vis the dollar and the loss of a major share of an already limited share of the work served to exacerbate things.[192]

Hymer said that gearbox production work would be picked up by Pratt & Whitney in the U.S. with no slippage in delivery schedules for the F-16's.[193]

P&W, which already had been producing the majority of F100 gearboxes, compensated for the loss of DISA by making its share of the units. There was no interruption. But Hymer stressed at the time, "Pratt & Whitney feels an obligation to put all the work back into Denmark".[194]

Still, Hymer felt that having the work done in Denmark was the ideal solution. On the other hand, "Whether we can put all the work back (in the country) is the question."

Some four months later, in late April 1981, Pratt & Whitney had not yet found a Danish successor to DISA for the production of the F100 gearbox module. Given the small size of the Danish aerospace industry and the difficulty of producing the gearbox module, Pratt & Whitney was considering by that time awarding the contract to a non-Danish firm and arranging for Denmark to produce a different component for the F-16.[195]

Pratt & Whitney had meanwhile been wrestling with another EPI problem. By the end of July 1980 Fabrique Nationale had delivered 83 engines, being 20 engines behind schedule.[181] FN was attempting to recover and get back onto the original schedule by the following January when it was hit by a strike in September 1980 and then again in February 1981. By the end of March 1981 FN had delivered 127 engines to Fokker and SABCA, but was by then 30 engines behind schedule. At that time, however, a Pratt & Whitney spokesman was able to announce that the aircraft production schedule had still not been impacted. Baring any further strikes, FN was hoping to be back on schedule by January, 1982.[196]

16. Schedule and Cost Problems Emanating from the European Socio-Labor Environment and Rapid Production Startup

a. The Socio-Labor Environment

General Dynamics was rudely surprised by the Europeans' shunning of multiple shifts and overtime in favor of long, steady employment. Europe's socio-labor environment is marked by: strong employee unions; many different unions representing skilled and semi-skilled workers; a high rate of unionization (70 - 75% of employees) including supervisors and middle management; a heavy reliance on industrial courts and/or arbitrators; a 38 hour work week; little overtime; one shift a day; and factories that shutdown for one month every year when the entire work force goes on vacation (while the random U.S. pattern has little impact on production).[197] The goal of steady, long-term work is embedded in the laws of most European countries, where the tax structure has a more progressive rate structure than in the U.S., offering less incentive for employees to work overtime, and companies must bear enormous severance payments for anyone who is laid off. Whereas any American corporation that has operated in Europe is well aware of these basic facts and their ramifications vis-a-vis skill levels, tooling up and schedules, General Dynamics had never before operated there.

In contrast to the U.S., where the aerospace work force is highly mobile, going to wherever the contracts are, in Europe most firms have extremely low turnover rates. This results in generally higher skill levels among workers in Europe. The Burchfield study cited as an example,

> Machined parts produced by Fabrique Nationale under a subcontract and the supervision of Pratt-Whitney provide finishes far greater than required by the drawings and specifications. This was similar at other manufacturers under contract with General Dynamics.[198]

The other two major consequences of these differences between the U.S. and European socio-labor environments involve the amount of duplicate tooling and the longer production times required. On the first of these issues Kraar pointed out,

> The NATO countries bought the F-16 for a guaranteed maximum price of $6,091,000 apiece (in 1975 dollars), including the cost of special tooling for European production. General Dynamics, however, calculated these expenses on the basis of its own multiple-shift operation in Fort Worth. Because the European coproducers operate mainly on a single-shift basis,[199] they require nearly twice as much tooling as General Dynamics originally estimated. None of the purchasing nations wants the political embarrassment of raising the official price. With some deft sleight of hand, the European governments are quietly picking up the extra tooling expenses and not counting it as part of the F-16 price.[200]

Gen. Abrahamson cited schedule generally as the most critical parameter facing the program, and especially the longer time it takes to build subassemblies and aircraft in Europe. For the aircraft coming off the two European assembly lines it took 36 months as opposed to 26 months for the U.S. produced aircraft. Consequently, the proper meshing of production schedules on both sides was a major planning and managerial task for the two U.S. prime contractors.

General Dynamics had to offer the Air Force estimates as to the cost of making the plane in Europe prior to their having fully grasped how European manufacturers operate.

> Only when the European companies started bidding on their shares of the F-16 did General Dynamics finally realize that the lead times would be longer and the costs higher than expected.
>
> The belated awareness of European work habits had a far-reaching impact. "Suddenly," says Scheideman, "all the integrated schedules

that we'd worked out didn't fit, and a whole year's work was knocked out." It took tedious reshuffling to keep the planes ordered by the U.S. Air Force on schedule, for many of them are slated to have European components. Unless the output in Fort Worth and in the overseas plants meshes precisely, remarks a General Dynamics production expert, "we'll end up with a fighter that has no center fuselage."[201]

b. Solutions

This problem was resolved in two ways:

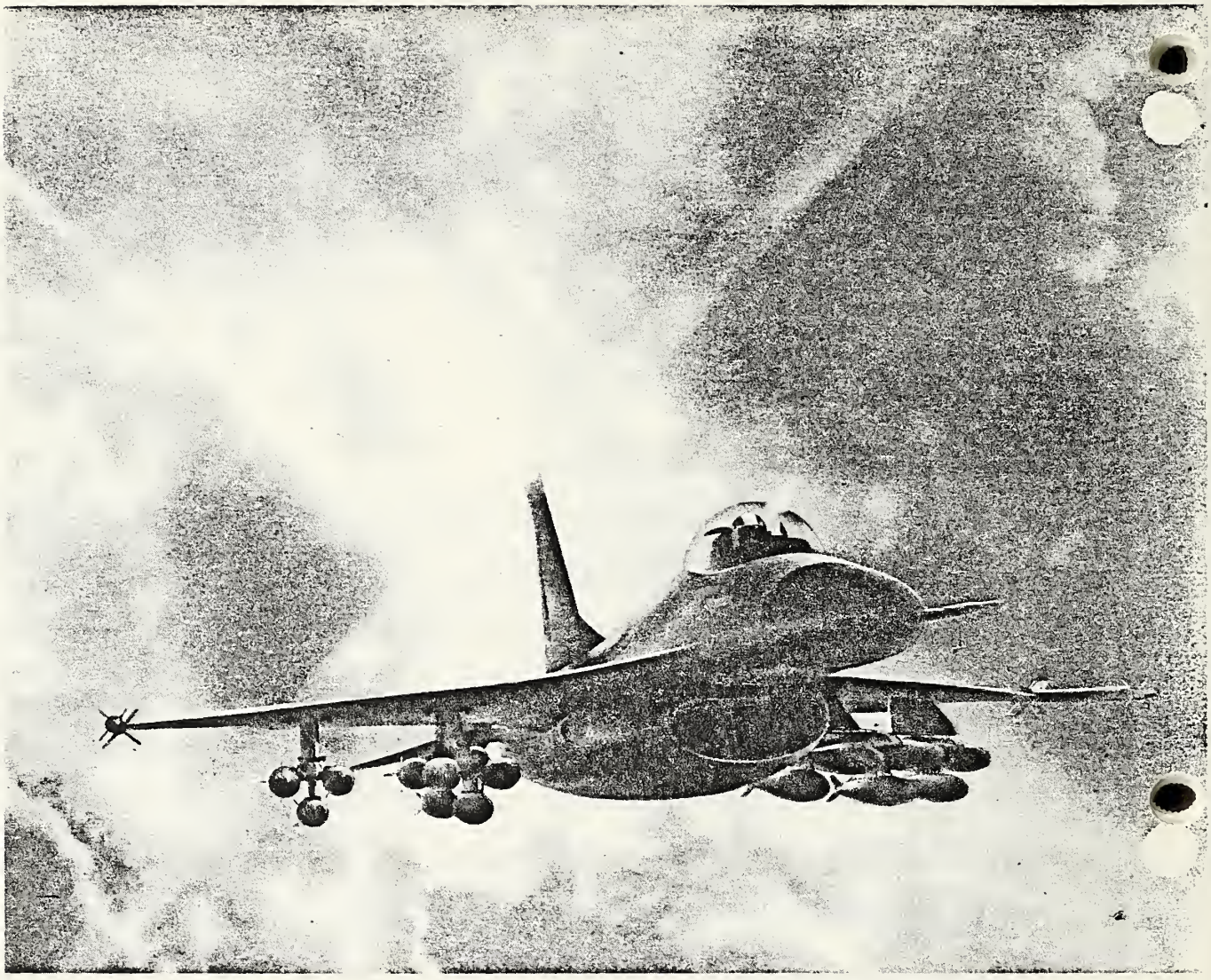
1. European manufacturers began tooling and manufacturing preparations ahead of their U.S. counterparts wherever possible, and;
2. The first planes destined for the USAF were to be of 100% American composition instead of 90%.

After several years when the European manufacturers catch up, they will be compensated with a larger share of components in the later American-built planes than was originally contemplated.

Burchfield in his March, 1979, study for USDR&E stated,

> The environment in Europe is considerably different than the U.S. and must be considered. For example, the nations do not consider it a serious problem to miss a production schedule. Approximately 40% of the F-16 line items on contract in Europe are behind on established production schedules. These shortages are generally being made up by the U.S. prime contractor and subcontractors. Not meeting production schedules can be a serious problem when a manufacturer in another country is dependent upon the item being produced to meet another schedule.[202]

The European subcontractors have continually displayed over optimism vis-a-vis the time required to get up to speed on a given task, manpower requirements, and schedules in general. Lt. Col. Kehl of the F-16 SPO felt this was in part explainable by their not being used to having to live with the close surveillance of an AFPRO forcing them to be constantly accountable for commitments.

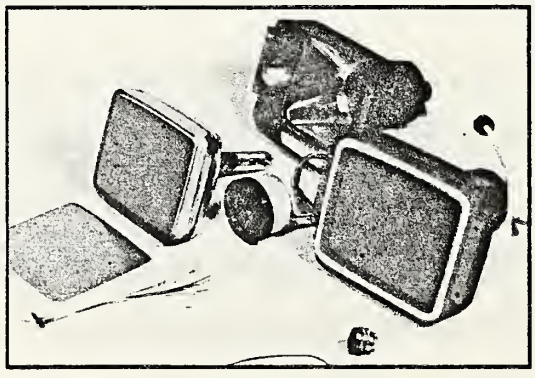


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c. Engineering Changes

Setting up early for second source production in Europe however, involved the aggravation of an already serious problem. The F-16 had only recently entered engineering development when the consortium selected the F-16. Still in the developmental phase when the EPI started manufacturing, numerous engineering changes had to be incorporated by the EPI. Carrying out these changes in parts, tooling and manufacturing processes caused numerous problems for both U.S. industry and EPI's.

The afore mentioned GD decision to retain the manufacture of the forward fuselage at Fort Worth for all F-16's was an attempt to alleviate this problem. With the high rate of change activity in this section of the airframe, it was better to have only one manufacturer.

Burchfield came to the following conclusion

> "Full scale development should be completed before establishing coproduction in such a consortium arrangement because of the complexity of development changes, effectivity of these changes, and related costs. This also requires concurrent changes in hard tooling by both the US and foreign nations. Changes such as these cost approximately 100 times as much as when the development is finalized and changes are incorporated before production begins."[203]

Although in an ideal situation this would be the logical course to follow, the fact that this problem has resurfaced repeatedly in collaborative programs, from the Hawk and F-104G Starfighter programs of the early 60's to the Roland and F-16 programs of the late 70's would lead one to suspect the choice isn't all that simple. In all these projects there seems to have been an element of surprise in the reactions of the recipients of the technical data package (TDP)

(be they subcontractors or licensees) to the proportions assumed by the lack of the configuration stability (and therefore maturity of the TDP being transferred).

In any case, even if adequately foreseen, the choices would have been less one of avoiding the problem, than figuring into the equation the inevitable disruption and cost involved in engineering changes caused by the demands of the replacement schedules of the user armed forces, and the work load/capacity of the industries that are to serve as the second source. Consequently, these and other factors have to be properly assessed early on in the project. With eyes opened to this delemna, tradeoffs can be made which permit the program to chose the lesser of evils and to minimize, not avoid, any resultant disruption caused by the heavy flow of engineering changes emanating from the developmental phase and early low-rate production.

17. Other Issues Bearing On Transnational Subcontract Management

a. Intra-Consortium and Intra-Country Distribution of Contracts

Though the total value of offset contracts placed in the four EPC's has been satisfactory, vis-a-vis approaching the 58% goal, there has been an imbalance among the four countries. Belgium and the Netherlands, with established aerospace industries, have the highest proportions, especially the Walloons. Norway and Denmark have done much worse. It must be remembered however that the MOU placed an obligation on the U.S. to place offsets in line with the 10/40/15 formula, for the consortium countries as a whole, not on a country-by-country basis.

As of Spring 1977 with roughly 90% of the contracts earmarked for the EPI's having been awarded and totaling a value of $2.09 billion, the country order/work shares were as follows:[204]

Country	% of total EPG 348 Aircraft Order	% of Contracts Awarded to EPI's
Belgium	33%	57%
The Netherlands	29%	22%
Norway	21%	14%
Denmark	17%	7%[202]

As we saw with the case of Westinghouse, those U.S. subcontractors caught in the final squeeze, when the USG tried to somewhat rectify this imbalance through those contracts yet to be awarded, had their already difficult tasks further complicated.

Intra-country as well as intra-consortium distribution also proved to be an issue. Even with the award of the lions share of the work to Belgian firms, the Belgian government wanted to placate the countries regional rivalry by providing contracts to the Dutch-speaking Flemish north as well as the French-speaking Walloon south. Since almost all of the Belgian aerospace industry is located in the Walloon area, this special requirement proved to be virtually impossible to satisfy. (This ethnic division had previously entered the picture during the evaluation period of 1974-75 with a Flemish bias toward the U.S. aircraft and a Walloon bias toward the French one, but reversed itself in 1982 during another foreign aircraft evaluation, this time for replacement of the Mirage V, the Walloons having since become entrenched on the side of the F-16.)

Another case of intra-country distribution that originally concerned General Dynamics, was the socio-political requirement of Fokker to spread its portion of F-16 parts and assembly among six widely scattered plants.

b. American Technology Being Bureaucratic and Out of Proportion to the Smaller EPI

Another major concern expressed by the EPI's was that of being overburdened with paperwork from the U.S. SABCA's Managing Director, Pierre Georges Willekens stated, "We can't afford to pay that much for something that lends nothing to the quality of the product and does not increase the value of the product."

Willekens felt that the EPI's could,

> be more competitive with the U.S. if the generally smaller European manufacturers were not burdened with the administrative workload

involved in this program. Because these companies generally are much smaller than their U.S. counterparts, he said, "the administration system applied by the U.S. government is out of proportion to the activities in our country."

Willekens estimated that these reporting functions may account for up to 30% of total system cost. He conceded however, that detailed reporting was necessary in some areas.

> "This is the first time we have worked with fracture-critical parts," he said. "We need to keep records on this. Okay—there is a minimum that must be done here.[205]

Kate Galle, a Danish Ministry of Commerce representative involved in the program, further observed,

> My impression is that American technology is very bureaucratic. This is very strange to us. It limits participation by smaller firms unable to handle the paperwork burden.[206]

Representatives of the CASEUR office in Brussels conceded that,

> European contractors feel a bit over-managed as a result of the large U.S. onsite teams and reporting requirements.
>
> But it's the price you pay to do business in this program," asserted Lt. Col. Ronald A. Fullerton, deputy director of the office. "We would like nothing better than to have complete confidence in all the European subcontractors, and not have to do this.[207]

The Deputy Director suggested, however, that,... "as confidence grows with experience, some of the requirements may be relaxed."[208]

c. Loadings

Some European subcontractors had difficulty competing with the U.S. industry because of the U.S. industrial practice of adding charges to production costs to cover administration, overhead, profit and handling. These charges are

called loadings and are added each time an item is handled. For the F-16 program, U.S. subcontractors handle many items more often than ordinarily; shipping them to, and receiving them from Europe. This problem first surfaced in early 1976 for the F-16 program. The issue arose over the impact of loadings on GD's U.S. suppliers' ability to place an adequate amount of work on a reasonably competitive basis with the four European Participating Industries (EPI). Initially, U.S. suppliers pointed to the premium, one which began to increase exponentially past a certain minimal amount of easily second-sourced work, as the major impediment to placing an adequate amount of work with the EPI. The EPI retorted, however, through their respective governments, that it was not their bids per se that were pricing them out of the action, but the loadings placed on their proposals by the first tier U.S. suppliers. The European Participating Governments (EPG) protested on their own behalf as well over the impact that these loadings would have on the price of their F-16 aircraft, 40 percent of which was to be EPI content (this figure was only 10 percent of USAF aircraft).

The U.S. Government's position on all this was that the extra charges by U.S. suppliers were totally legitimate. They reminded the EPGs that, although there had been initial controversy, they had already agreed to accept the cost accounting principles contained in the U.S. cost accounting standards (CAS), and the USAF was able to ascertain that the U.S. contractors had been consistent in applying the relevant factors. Furthermore, a great deal of study was subsequently done by the USAF to make sure there was no double costing. The results of the study showed that loadings had been properly applied in all cases. Though conceding their legitimacy, the U.S. Government has continued to try to

minimize loadings and has maintained close surveillance assuring that they are applied only in proportion to the value-added at each stage.[209]

The EPG, for their part, have continued to be accutely aware of loadings with the issue tending to resurface periodically.[210]

The EPI production effort, and U.S. industrial management of it, are highly decentralized. GD feels any premium paid for this structure is well worth the cost given the constraints under which the program has had to operate. The one-to-one teaming, though involving substantial loadings, has been effective. If the loadings weren't there, they would be replaced by royalties on the data and know-how transferred. GD believes one must be cautious not to denigrate the services provided by the U.S. vendors.[211]

General Dynamics has not gone direct to its second tier EPI suppliers follow-on for spares either — even though acknowledging they would save on the loadings, extra time, and elongated communications chains resulting from the intervening layer of U.S. industry — for several reasons. The first two being strategic (long-term impact on the program's and corporation's business base) and the latter two are more operational in nature.[212]

The first and most important reason cited by GD was the impact this would have on their program and overall business relationships with their U.S. suppliers. Of particular importance was GD's high degree of dependence on suppliers to support future marketing efforts that involve co-production. If GD took business away with one foreign country sale, there is the danger that GD might do the

same with another country; after the U.S. supplier had assumed the trouble and risk of setting up a future competitor. The other policy consideration was the dangerous precedent such a move would create with regard to AFLC and the possibility of AFLC being tempted to cut GD out of the loop prematurely at some future date for spares.[213]

There were also operational issued which were of import to GD's decision not to go direct for spares. They involved: (1) industrial property rights (IPR) and (2) configuration and engineering management. On the first point, assuming that the drawings were not proprietary (but were U.S. Government owned) there was always the possibility that any royalty for know-how (or other IPR compensation replacing the loading) could approach the original loading. On the second point, if GD went direct to a firm that is building to drawings, GD would have to be fully responsible for, or separately subcontract configuration management and engineering support. This could be of particular difficulty for the many subsystems for which the design was still somewhat fluid. And again, GD would very likely find itself having to turn around and negotiate an engineering management contract with the U.S. supplier.[214]

d. Need for Intervention by U.S. Contractor Teams

As with Raytheon's HELIP experience, there has been the necessity to send U.S. contractor teams over, on emergency basis, to bail out European subcontractors (often for an extended period).

e. Though No EPI Participation in Engineering Development, Technology Transfer was Significant

As discussed previously, there has been significant technology transfer to the EPI's during this program. Some individuals among the EPG's and EPI's tended, however, to down play this preferring instead to emphasize the fact that the EPI did not have any significant design or engineering development responsibilities where the real gain in technology comes. Complaints included comments along the lines of, as opposed to being a multinational program, it was just a glorified subcontracting project, be it a gigantic one. Though essentially true on the industrial side, as we've already seen, the EPG's did have some limited input on the governmental side of project management during engineering development.

In any event this is a totally unjustified criticism since the Danish and Norwegian governments and industries had never seriously considered assumption of a role of developmental partners on any new fighter project. While the Dutch and Belgians had previously considered this option, they were both early drop outs of the MRCA Tornado project. They had dropped out because they had not wanted to assume the responsibilities of a partner in the development of a fighter, knowing full well that their proportionate shares would have not given them adequate leverage in decision making corresponding to the investment made and risks assumed. This was especially true as the requirement would tend to be one steered more along the path chosen by the British and Germans, one which was expected to and did lead to fighter tailored to performance characteristics far more expensive than these smaller countries either needed or could afford.

Instead they had opted out of development so as to be able to make a better choice at a later date; allowing them to pick among existing fighters, one more closely conforming to their performance-cost trade offs, given the replacement schedule constraints.

Furthermore, in spite of the nature of the project for the four EPI being that of second source production subcontractors, as we saw under the sections and subsections covering the GD, Pratt & Whitney, Westinghouse and other subcontract efforts, there is no down playing the considerable transfer of technology involved.

f. Subcontractor Ownership

In the words of GD's vice-president, Scheideman, "We were as nervous as mother hens,". . . in approaching the European firms. One of the reasons for this wariness was the ownership of several of its principal prospective subcontractors—which involved its two competitors; Northrop and Dassault-Breguet. Dassault-Breguet owns half of SABCA, while Northrop owned 10% of Fokker-VFW. In addition both firms are Dassault partners and subcontractors in several other programs as well. "But General Dynamics . . . gradually came to appreciate that such corporate relationships are customary in Europe and do not necessarily influence other business."[215]

18. The GAO Report on the F-16

In the fall of 1978, the General Accounting Office circulated a draft report on the F-16 multinational fighter to the European national participants for comment before final publication (scheduled for November). This was to prevent the recurrence of ruffled feathers by the European participants after the GAO failed to submit drafts of other reports during the two previous years.

At the same time, the GAO, which had been monitoring the F-16 program, had a separate research team in Europe to report on lessons learned from current multinational programs, taking an especially close look at the Panavia Tornado multirole combat aircraft (MRCA).[216]

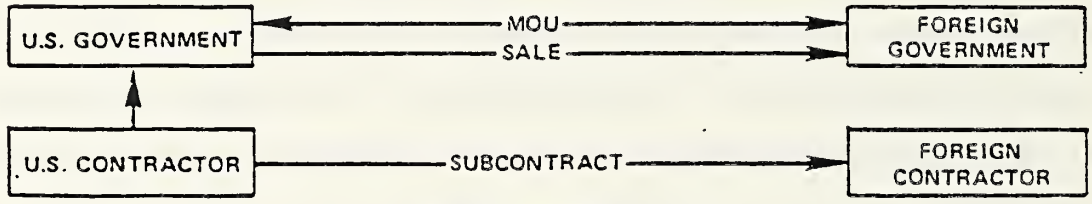
The GAO report circulated in draft form included, among others, the following conclusions:

- Foreign manufacturers involved in the General Dynamics F-16 fighter European coproduction program are being driven up the wall by swarms of American auditors, quality control specialists, and flight safety experts.

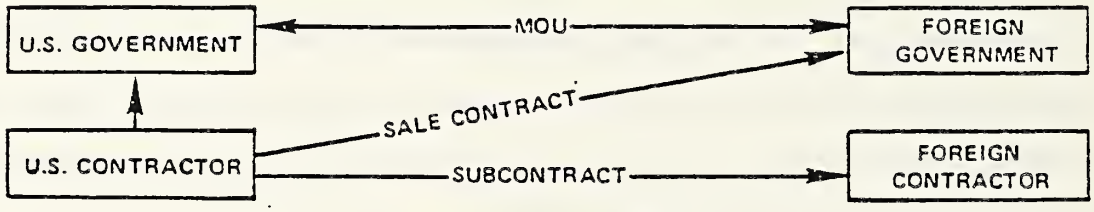
- If coproduction is to work, weapons systems must be uncomplicated and involvement by Congress and the Pentagon must be greatly reduced.

Contrast of the Foreign Military Sales Arrangement of the F-16 Program with Arrangements "A" and "B"

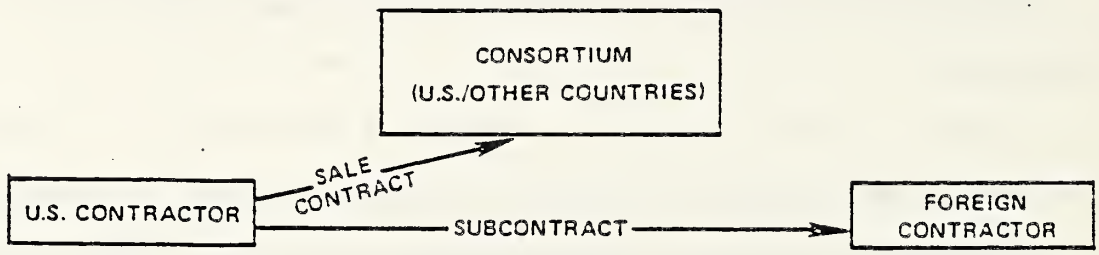
F-16 ARRANGEMENT



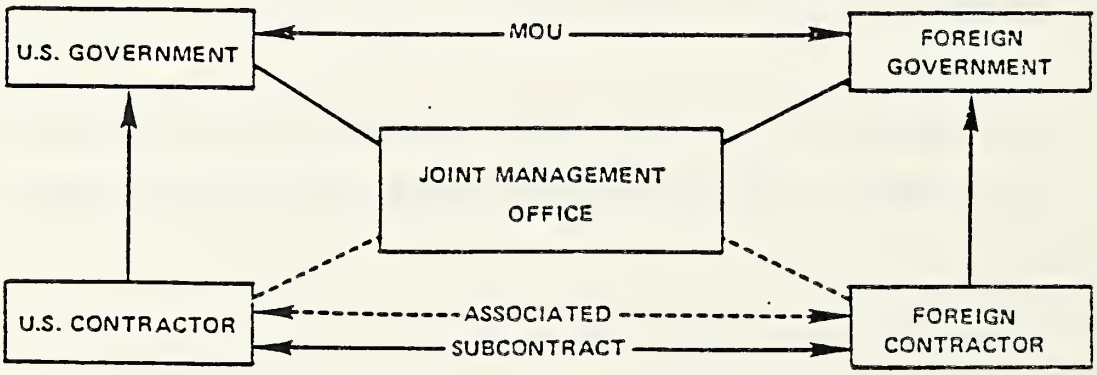
ARRANGEMENT "A_1"
(CONTRACTOR TO FOREIGN GOVERNMENT)



ARRANGEMENT "A_2"
(CONTRACTOR TO CONSORTIUM)



ARRANGEMENT "B"
(NATIONAL CONTRACTOR TO NATIONAL GOVERNMENT)



Source: GAO, 1979

- Under a new proposal, Congress would approve a memorandum of understanding (MOU) prior to a project, and then withdraw from the process. The Pentagon's management role would be reduced. Problem solving would be on an industry-to-industry basis, rather than government-to-government, and most of the regulations relating to foreign military sales would be waived.

The U.S. regulations are partly to blame for a coproduced F-16 costing "substantially more" than if it were U.S. produced, a GAO official was quoted as saying at the time the draft was circulating. Aviation Week & Space Technology reported at the time that, "Nervous coughing already has been heard from the Pentagon, where two officers said last week they will "urge caution" in any reduction of their management role."[217]

The GAO report, entitled A New Approach Is Needed For Weapon Systems Coproduction Programs Between The United States And Its Allies was released in its final form on April 12, 1979. It made four recommendations on the basis of the F-16 coproduction experience, which suggested the need to alter the present system used to establish and manage such coproduction efforts.

(a) A New Approach

Consider a direct sale approach as the accepted method of U.S. prime contractors engaged in coproduction programs, thereby removing such programs from foreign military sales procedures. Under the direct sale approach, the U.S. companies would contract directly with the foreign government or consortium buying the product.

Arrangement "A"

An american prime contractor, linked contractually with foreign subcontractors for the production of a weapon system, would contract directly with the foreign governments or government consortium to produce the weapon systems as agreed in the MOU. There would be no government-to-government contractual relationship beyond an MOU. The prime contractor would bear the sole responsibility for the product. Neither would it be necessary to have direct contractual arrangements between the foreign contractors and their governments. This arrangement can take two forms: contractor to foreign government (A_1); or contractor to consortium (A_2).[218]

Arrangement "B"

The associated contractors, both U.S. and foreign, would contract directly with their respective governments. This type of arrangement would be applicable in cases where the foreign contractors are producing the end products to be purchased by the foreign governments with the U.S. contractor furnishing parts.

As we saw at the beginning of this project history this was the contractual approach taken for the prior F-104G project where the Europeans as such operated as licensees, but it was not repeated for this much smaller non-subsidized effort.

The report did qualify its suggestions though, pertaining to the various direct sale options described above by stating that,

In proposing a direct sale approach for coproduction efforts, it must be pointed out that in some circumstances certain parts of a program may and should be placed under foreign military sales procedures.[219]

(b) Timely Congressional Review

Require that a Memorandum of Understanding, signifying the commitment of the U.S. and foreign participants to join in a coproduction program, be submitted for review as soon as the points of agreement have been identified. The Congress would either concur by taking no action or object by disapproving the MOU.[220]

This resulted from the fact that, as required in the Foreign Assistance Act of 1974, a letter was submitted to Congress in April 1975 notifying it of a possible F-16 sale to 4 European nations, but not the conditions of the sale contained within the MOU signed in June.

> The congressional notification of the impending F-16 coproduction program met the legal requirements, but it was not made at a point in time when all the pertinent data that was later to be included in the MOU was available for congressional review. Thus, congressional notification was too early to provide the necessary data.
>
> Under present arrangements, congressional prerogatives are significantly restricted after an MOU is signed.... It is evident that in such cases, emphasis should be placed on obtaining congressional review of the MOU—it being the basic agreement and, in our view, the most appropriate document for the Congress to review.[221]

(c) Adjusting Procurement Laws

The report summarized some of the principal procurement laws and regulations that caused difficulties for the F-16 program and whose waiver or modification needs to be considered for future ventures of this kind. The F-16 was one of the first programs in which foreign contractors were guaranteed a specific share of a system procured by the U.S. government for its own use (10% in this case) in return for a purchase of the aircraft by a contractor's government. This made the waiver of the flow down of ASPR clauses to European subcontractors more difficult.

The NATO AWACS sale originally had similar problems, but these were also eventually circumvented, assisted by a decision not to use the FMS approach but instead a direct sale from the U.S. prime contractor to the

consortium (Arrangement A-2 above), a NATO subsidiary organization including 12 funding governments.

There are two general areas of friction where flow down to foreign suppliers is involved:

(a) The protection of domestic commercial interests:

- Prohibitions against purchases of foreign food, clothing, textiles, specialty metals, or construction of naval vessels in foreign shipyards (annual inclusions in Department of Defense Appropriation Acts).

- No research and development contracts dealing with weapon systems may be made with foreign sources when an equally competent domestic source will perform the service at a lower cost (Public Law 92-570, sec. 744).

- Army supplies are to be made in U.S.-owned factories or arsenals so far as can be done on an economical basis (10 U.S.C., sec. 4532).

- No defense funds may be used to buy items other than U.S.-manufactured items without adequate consideration given to U.S. firms in labor surplus areas, U.S. small businesses, and the U.S. balance of payments (22 U.S.C., sec. 2791).

- Defense supplies must be shipped on U.S. flagships unless charges are excessive (10 U.S.C., sec. 2631).

Since industrial participation programs involve sovereign nations, the high visibility of these explicitly discriminatory national regulations are grating.

(b) Contracting, auditing, and accounting procedures:

- Contracts for property and services are to be made by formal advertising (10 U.S.C., sec. 2304-a).

- Contracts are awarded to the lowest responsible bidder on a competitive bid basis (annual inclusion in Department of Defense Appropriation Acts).

- No advance payments by the U.S. purchaser unless determined that such is in the public interest (10 U.S.C., sec. 2307).

- "Vinson-Trammel Act," dealing with excess profits in aircraft and naval contracts (10 U.S.C., sec. 2382).

- Contract warranty that no third-party agent was retained to solicit the contract for a commission or contingency fee (10 U.S.C., sec. 2306-b).[222]

Other troublesome procedures have included the afore mentioned audit of contractor records by the Department of Defense, plus the disclosure of cost and pricing data.

All parties agree that accountability and consistency must be maintained in the accounting practices of each nation, and that program oversight must be maintained. However, attempts to satisfy the specific accounting and auditing requirements of both the United States and the other participating countries have created significant problems stemming from national sovereignty prerogatives that each wishes to retain.

If coproduction efforts are to be a more frequent arrangement between the United States and certain of its allies, a thorough review of the appropriate procurement legislation and regulations should be undertaken by the Congress in order to identify and evaluate the changes necessary to provide the needed flexibility.

The GAO recommended that the Congress consider:

> Review appropriate legislation and procurement regulations in order to identify and evaluate the changes necessary to provide the needed flexibility for a realistic and efficient application to cooperative ventures with foreign countries. It is expected that foreign participants will take comparable reciprocal actions when they are needed to facilitate such ventures.[223]

(d) Establishing Comprehensive Coordination

The GAO further recommended that the President consider, within the context of his current executive reorganization studies, the establishment of an independent interagency administrative or coordinating mechanism to provide policy and management guidance and to act as a clearinghouse for industrial participation programs.[224]

The reason given for this was:

The possibility of increased industrial participation programs will create a tremendous need for close coordination between various branches of the U.S. Government.... Present administrative arrangements do not appear to offer the centralized administration that industrial participation efforts needed for efficient decision making and policy interpretation . . .

Increasing activity in industrial participation programs will require an interagency or coordinating mechanism that would provide policy and management guidance, and act as a clearinghouse for industrial participation programs. The organization could consist of representatives of the:

- Department of Defense—implementation of program,

- Department of State—foreign policy and security objectives,

- Department of Commerce—export control,

- Department of the Treasury—international finances and currencies, and

- Department of Labor—employment issues.[225]

19. Program Status

a. An Overview of the USAF Program and Foreign Sales (1975-1982)

(1) Production Milestones

In January 1975 the USAF selected the General Dynamics YF-16 for full-scale development as its Air Combat Fighter and awarded the firm a fixed price incentive contract valued at $418.0 million. Pratt & Whitney received a similar contract, worth $55.5 million, for F100-PW-100 engines at the same time. GD's contract originally called for 15 engineering development models, but this number was shortly thereafter cut back to eight.[226]

The first preproduction aircraft flew in December 1976, and the eighth and final pre-series F-16 flew in June 1978. First flight of a production F-16A was in August 1978, with delivery to the Air Force the same month. The first Belgian-produced aircraft was delivered in January 1979, followed by the first Dutch-produced one, which entered service in June of that year.[227]

(2) NATO RSI Payoffs

Congressional hearings for the FY 1979 budget focused in on the project and trade-offs involved in this major NATO RSI initiative.

Testifying before the Senate Defense Appropriations Subcommittee, William J. Perry, the Carter Administrations' Under Secretary of Defense, Research and Engineering (USDR&E) reported in March 1978 that the United States had "not gained economies of production scale" in the F-16 aircraft production program. Dr. Perry added, however, that the U.S. is no worse off than it would have been in producing the F-16 entirely on its own.

The real cost savings would be realized, he intimated, in the amortization of R&D costs and in savings introduced through NATO standardized logistics, spares and training for the system.

Three months later, in testifying before the House Armed Services NATO subcommittee, Assistant Secretary of the Air Force (R&D and Logistics), John J. Martin was questioned as to whether there might be an adverse effect on the U.S. economy. "I think there may be some improvement," Martin said. We said the joint F-16 program "in the long run will mean many more jobs," because of the quantities of aircraft that will be built.

The witness conceded that F-16 total procurement costs would be lower if all the aircraft were built in the U.S. — but only if the total number to be procured were the same as contemplated under the agreement with the consortium, which both they and the subcommittee members agreed was an academic proposition.

In any case, Martin testified, there are offsetting advantages in sharing the manufacturing. In addition to beefing up NATO's tactical airpower, and the benefits of standardization, there is recoupment of much of the F-16 R&D cost — slightly more than $500,000 per aircraft — and other recoupment on support equipment.[228]

(3) Signing of the Four LOA's in 1977 and the Exercising of Options in 1978

The four EPG's decided on the F-16 over the French and Swedish contenders and each signed the MOU with the U.S. in early June 1975. The U.S. government's four Letters of Offer and Acceptance (LOA) were signed by the EPG's almost two years later. Norway signed its letter of offer and acceptance May 2, 1977 for 72 F-16's; the Netherlands signed May 3 for 102; Denmark, May 4 for 58 and Belgium, May 5 for 116 for a total of 348 aircraft (including options for 42 fighters).

The signing came after an easing of financing terms by the U.S. government as a result of recommendations of the Multinational Steering Committee. This was accomplished by waiving the reserve cash in the initial payment for termination protection, by offering options on when full-scale development recoupment will be paid, and by establishing banks in each country to assure fast payment to contractors.[229]

For R&D recoupment the countries now had a choice on prepayment, payment on time or late payment, but still to be settled was the issue of interest on these progress payments.

In July of the following 1978, the Pentagon was able to announce that the EPG's had picked up their 42 options on the F-16 fighter, assuring that the total buy would be 348 aircraft. This 42 aircraft option included 16 for Belgium, 10 for Denmark and 18 for the Netherlands.

(4) The Order Book as of 1982

As of 1982 the order book for the General Dynamics F-16 Falcon was as follows:

USAF	EPG	Third Countries
2333 (planned) (of which 831 were already procured)	Belgium 160 (116 + 44)	Egypt - 40
	Denmark 58	Israel - 75 + 75
	Netherlands 156 (procurements of 102 + 54) 57 (additional planned)	Korea - 36
	Norway 72	Pakistan - 40
		Venezuela - 24
		Turkey - 160

For more on the sale to another NATO member, Turkey, and the offsets involved, see Chapter 11.

(5) The 1982 Multi-Year Procurement Contracts

Following the Reagan Administration's entering office, the Pentagon's proposed budget for FY 1983 and five-year plan reflected large increases in orders for the F-16, the Navy/Grumman F-14, and the Air Force/McDonnell Douglas F-15 aircraft procurement programs.

In drafting and approving the new defense program sent to Congress, the Defense Department and the Administration approved procurement of a total of 2333 F-16s, an increase of 945 over the 1388-aircraft program planned up to that point, 845 F-14s, up 348 from 497, and 1107 F-15s, up 342 from 765.[230]

On January 26, 1982, the Air Force and General Dynamics signed the first of two contracts for the multi-year procurement of 480 F-16 airframes between FY 1982 and FY 1985.

The $480.5 million contract covered advance procurement of long-lead items and bulk purchase parts for the F-16 airframes and ran until October. A second contract, worth approximately $2.5 billion, would be signed later in the year and would cover full production of the airframes.

The four-year procurement plan was expected to total $3 billion, the largest multi-year contract ever awarded by the Air Force, and was expected to save the government $350 million.

The plan did not cover the Westinghouse AN/APG-66 radar or Pratt & Whitney F100 engine used in the F-16. These items were to be furnished to General Dynamics by the government as has been done for those F-16s already ordered by the Air Force.

If the four-year contract proves successful in saving money, the Air Force was expected to place an order for another 303 F-16 aircraft under a second MYP contract that would begin in FY 1986.

This multi-year procurement contract was made possible by the 1982 Defense Authorization Bill which contained provisions extending multi-year awards to major weapons systems.

Delivery of the 480 F-16s was to take place between June 1983 and May 1987 at a rate of 10 aircraft per month.[231]

As covered earlier in this subchapter, the inability of the U.S. government to make this sort of multi-year commitment had caused a certain degree of resentment in the early years of the F-16 program on the part of the European partners when this sort of procurement was still not legal. The USAF could make no firm production commitment or binding purchase obligation until the DSARC IIIB recommendation to commence full-scale production in October 1977. Even then, in line with U.S. procurement practice the commitments could be made only on a year-by-year basis — an initial batch of 105 aircraft for FY 1978.

(6) Third Country Sales

Another point of irritation in some European quarters centered on third country sales and especially on the restrictive arms export policy introduced by the Carter Administration shortly after it entered office in January 1977. One incident involving this issue attained a certain degree of visibility at the 1979 Paris Air Show.

King Hussein of Jordan had wanted to purchase the F-16 but the Carter Administration was unwilling to permit the sale. This attitude by the U.S. State Department had reportedly upset the European members of the F-16 fighter consortium because of its impact on their ability to recoup their F-16 investments through third-country sales.[232]

Hussein visited Le Bourget and spent time examining the French Dassault-Breguet Mirage 2000 fighter parked directly in front of the General Dynamics chalet. During the show, according to Defense Department officials, the king was believed to have ordered 60 of the French fighters (in fact no such order was made).[233]

Another incident at the same Air Show involved Taiwan. Both Sen. Cannon, the official U.S. representative to the Air Show and the U.S. Ambassador to Belgium, Mrs. Anne Cox Chambers, agreed to initiate action with the Carter Administration on behalf of the Taiwanese to fly the aircraft.

As the U.S. Ambassador to Belgium, a country with vital interest in third-country sales of the fighter, Mrs. Chambers telephoned the White House from Paris to speak to President Carter. She was instead passed off to National Security Advisor Zbigniew Brzezinski, and received little satisfaction because the White House believed flights by Taiwan air force officers in the F-16 "were much too sensitive."[234]

Another nation interested in procurement of 80 of the fighters was South Korea. Two officers from the Republic of Korea's Air Force were permitted to fly the F-16 during the Paris show "But South Korea can't get the time of day from the Administration on the sale," a Defense Dept. official said. "It probably means the loss of the sale of another 80 F-16's."

A Pentagon official was quoted by Aviation Week & Space Technology at the time as follows:

> One reason the NATO F-16 fighter consortium was formed and agreed to produce the aircraft was because of the possibility of third-country sales. Now, they see the loss of these sales to France and other friendly foreign nations looming and they are upset over the obstinacy of the Carter Administration.[235]

This 1979 Paris Air Show is but one example among many, but it encapsulates a standard dilemma. Government Arms Export Controls will continue to be an issue in all inter-allied projects due to its significance within the overall foreign policy picture. This

applies, whether the U.S. Government is participating or is not, as all of the NATO member states have varying policies both amongst themselves and over time as governments come and go. As an alliance of sovereign social-democratic nations, this is a basic fact of life for NATO and all its associated defense projects.

b. Multinational Consortium Status (1979-1983)

(1) Start-up

The first European assembled F-16's flew in December 1978 and the first aircraft was delivered by SABCA in Belgium in January 1979. At the same time European components were flowing into the United States for incorporation into assemblies destined for both the Fort Worth and the Dutch/Belgian assembly lines.

Interavia reported in November 1979 on an extensive briefing from Major-General James A. Abrahamson, F-16 System Program Director and his staff at the System Progam Office (ASD) in Dayton, on the status of co-production, offsets and the transfer of technology.[236]

By way of background, Gen. Abrahamson started out,

> the F-16 program has always had a very high degree of 'concurrency', in which a large number of events in the design, test and production cycle take place in parallel. This introduces a high degree of risk, particularly in developing and refining the avionics. "Concurrency", he said, "delays the solid work that needs to be done in

the guts of the aircraft, in the weapons system. By delaying that you introduce a great deal of risk later on in the program. Most people do not understand that the F-16 is the most concurrent program we have, and as a result, when the co-production program began, logistics planning had started for the USAF, but it was not solid. In addition, the two production lines in Europe introduced another element making the F-16 the highest risk program around. Most people thought that because we had successfully flown the Air Combat Fighter prototypes, the program was a piece of cake".[237]

Much of the "solid design" work was already well underway when the MoU was signed and it was thought that the European program could get under way in six months, which, he stated, was "crazy".[238]

The first official contract with a European company was not signed until July 1976 and the first delivery planned from the European companies was based on a lead time of 37 months. Gen. Abrahamson pointed out that the Europeans did not have much to bid on. "It is the European tradition", he said, "to work from 'good solid drawings' in a 'build-to-print' program". Such drawings were not then in existence. Nevertheless, European industry made fixed-price proposals, and the program began.[239]

The last production subcontract to be let in Europe was not signed until June 1979 when NERA in Norway was awarded a contract for work involving threat warning equipment.[240]

At least for the F-16, Gen. Abrahamson pointed out that the biggest advantage in co-production was the resultant program stability it provided. Under the terms of the MoU, if any country made a decision resulting in a cost increase, that country would be obliged to pay the difference. Not only did this contribute to configuration and cost control but it also reduced options for tinkering with funding schedules. Congress at one point expressed its intentions to delay the co-production program after taking a close look at it, but the cost of delaying the huge multi-national machine set up to build the F-16 would have proved to be tremendous.

Unfortunately, as explained by Gen. Abrahamson, the pressures to get the program moving have resulted in (1) an imbalance in the national offset shares, and (2) some grumbling that the program has not produced the degree of technology transfer that was anticipated.

These two issues were treated earlier in this sub-chapter.

(2) Cost Comparisons

Judging from F-16 costs up to mid-1979, a U.S. production run of 650 aircraft had a $4.7 million unit cost. By comparison, the EPG produced aircraft cost $5.3 million each. If the co-production plan did not exist, the unit cost of the 650 aircraft for the USAF would be $4.55 million.[241]

And if the Europeans had elected to buy all U.S. made F-16's, they would have cost $4.2 million each.

This leads to the conclusion that as the result of co-production, the four European nations were spending approximately $1.1 million more on each aircraft, while the U.S. is, in effect, absorbing part of the cost of co-production and paying about $150,000 more per aircraft than it would without the European sale. Once the U.S. begins building the second batch of 738 aircraft as planned, and whether it is with or without co-production, these figures will clearly be very different.

(3) Disposal of F-104G Starfighters

The comencement of F-16 deliveries to the EPG's gave rise to yet another series of international arms deals involving the Lockheed F-104G's being simultaneously phased out of service. Belgium and the Netherlands agreed to turn over to another NATO ally, Turkey, those F-104G's that had been given to the two governments through MAP funding in the early 60's. The Federal Republic of Germany did likewise with many of its F-104G's as the MRCA Tornado entered service.

The Belgian transactions didn't end here though. In addition to the 18 F-104G's delivered to Turkey free of charge during the course of 1981, the Belgian government attempted to sell and then barter the balance of 34 for spare parts to be used in newer aircraft, including the F-16 and the Lockheed C-130 transports.

But in 1980 the Belgian government determined that it could not directly sell aircraft to another nation because of a national law. The law prevented the Belgian air force from selling the F-104Gs to Taiwan after the State Dept. had approved initiating negotiations between the two nations.

The Belgian's then turned to barter options. The Belgian government decided that 34 Starfighters could be traded instead of sold, especially to U.S. companies. One potential trading partner for the old

F104Gs was Lockheed Aircraft Service Co. Then, once traded, the F-104s could be sold easily by the U.S. company to other countries including Taiwan (which would again require U.S. government approval).

(4) AIM-9L Sidewinder Missile Procurement

The four EPG's approached the procurement of air-to-air missiles with which they were to arm their F-16's differently. Norway joined up with the three MRCA Tornado nations — the FRG, Italy and the UK — that were procuring the American short-range Raytheon/Ford Aerospace AIM-9L Sidewinder through a joint production arrangement for use on the other aircraft. The AIM-9L's are being built under license by a multinational consortium composed of the four national industries with the German firm Bodensee Geraetetecknik acting as prime contractor (see Chapter 7). The other three F-16 EPG's opted to procure their AIM-9L's through FMS channels off the U.S. production line.

(5) The 1981 House Armed Services Committee Report on Program Status

In April 1981 another congressional report was released on the F-16 program. The report stemmed from a House Armed Services subcommittee visit of the EPC's in August 1980, headed up by Rep. William L. Dickinson (R-Ala).

Dickinson concluded that the "multinational F-16 program has become . . . a model for future NATO standardization and interoperability efforts.

In one section of the report by the subcommittee on NATO standardization, interoperability and readiness, Dickinson stated that,

> While virtually all of European companies involved in the program have experienced problems in starting up their respective F-16 production-lines, this is not unique to the F-16 effort. All new production programs experience these growing pains. The program's success to date has been truly remarkable.[245]

Among the problems encountered over the prior year by the European subcontractors were:

- Bad weather in Northern Europe which forced Belgium's SABCA and the Netherland's Fokker to delay full implementation of their initial F-16 flight test programs. Of the days that were available for flying, SABCA lost 55 percent due to inclement weather while Fokker lost 34 percent.

- Belgium's Fabrique Nationale by July 1980 had delivered 83 Pratt & Whitney F100 engines to the USAF — 20 behind schedule.

- Denmark's Dansk Industri Syndikat (DISA) encountered "severe problems in producing the gearbox module" for the F100 engine and fell 35 units behind schedule. Pratt & Whitney subsequently terminated its contract with DISA.[248]

Dickinson noted that DISA, which had "acted as the Danish industry spokesman for the F-16 program, voiced concern about the imbalance in offsets that had developed between the Northern (Norway and Denmark) and Southern (Belgium and the Netherlands) EPI's. While Belgium and the Netherlands were receiving 71% and 51% offset against the value of their respective F-16 purchases, Norway and Denmark were only receiving 40% and 32% offset against their respective F-16 purchases. As the attainment of an evenly distributed 58% offset is an EPG responsibility, the Northern EPG countries are concerned that the EPG consortium is not doing enough to attain this goal."[246]

Dickinson stated that European participation had economically benefited the USAF F-16 program. Although the "Air Froce estimates that the additional cost to the USAF of European participation in the F-16 program is $257,000 (in fiscal 1975 dollars) per aircraft . . . when the direct benefits to the U.S. Government through research and development recoupments ($325,000), indirect benefits from corporate and personal income taxes due to additional sales ($364,000) and the benefits to other Defense Department programs through the spread of overhead ($99,000) are taken into consideration, a quantifiable net gain of some $531,000 per aircraft is realized by U.S. participation in the multinational F-16 program."

The subcommittee report noted that the purchase of the F-16 by Denmark and Norway has been cutting deeply into the defense procure-

ment budgets of these two countries . . . and elaborated on the program's place within the two nations' overall defense efforts.

Denmark's purchase of 58 F-16's, for example, consumes 60% of the country's procurement budget, "leaving only some $60 million available for other investment programs throughout the three services."

Because Denmark's Social Democratic government has apparently decided to limit defense spending over the next four years to a "no-growth" level, the modernization of the country's ground-based air defense, for instance, will be limited to the acquisition of Hawk batteries from the U.S. "as they are replaced in the U.S. force structure by the modern Patriot Missile System."[247]

Even with the addition of the 58 F-16's as a replacement for 40 F-100 fighter bombers, the Danish Air Force is considered relatively obsolescent, consisting as it does of 40 F-104 air defense fighters, 20 Swedish Draken fighter-bombers and 35 other reconnaissance, transport and rescue aircraft.

Under the Danish "no-growth" defense budget squeeze, the Danish Air Force "would decline from 116 combat aircraft to 80", due to the non-replacement of the F-104s when they are phased out during the mid-1980s, "and leave the problems of ammunition shortfalls and electronic warfare deficiencies unaddressed." Even if defense spending is increased by 3% annually in real terms, the number of Danish combat aircraft would total only 88 by the end of the 1980s.

In Norway, the procurement of 72 F-16s would also consume approximately 60% of the entire Norwegian military procurement budget between 1979 and 1983.

Under a long-term defense modernization program covering 1979-1983, the plan's first five years heavily emphasize Air Force procurement, although Air Force procurement money will drop off substantially in the following years as Norway turns its attention to the modernization of its Navy and Army.

"The predominance of the Air Force in Norway's initial 5-year modernization program reflects the compelling need to upgrade air defense capabilities through the procurement of the F-16 aircraft and the U.S. Roland missile system", the report states. "Other major Air Force procurements involve improved antiaircraft guns and upgraded control and warning capabilities."[248]

The 72 F-16s will replace the Norwegian Air Force's current fighter/attack fleet of 125 aircraft, "although an interim mix of older and new aircraft may be instituted to prevent numbers from dropping off that dramatically."

The subcommittee expressed concern, however, that "significant uncertainties appear to exist about the ability of Norway to execute the proposed 15 year acquisition strategy" because estimates of program costs may be understated.[249]

(6) Follow-on Orders by the EPG's

The original agreement by the four EPG's to jointly order 348 aircraft, subsequently led to follow-on F-16 orders by several of the EPG's, but this time acting independently.

(a) The Netherlands

In late 1980, The Netherlands was the first of the EPG's to buy additional F-16's, adding 22 more aircraft to bring its total F-16 buy up to 124 aircraft. The 22 were attrition aircraft to cover the RNAF for peacetime losses. These too would be assembled on the Fokker assembly line and would involve additional orders for Dutch industry for those parts that were already under construction in the Netherlands. This would not, however, mean additional component level work for the other three EPI, as the original four country distribution of work was for the 348 aircraft only, and the Netherlands was not interested in paying the concommitant premium for its follow-on aircraft.

The Netherlands was also planning at this time to procure an additional 71 F-16's (soon to increase to 89) with deliveries of these to commence in 1985. Unlike the initial orders this batch would replace the Northrop NF-5A's and NF-5B's which will be obsolete by the mid-80's.

In addition to the F-16's multi-role capabilities and the advantages of commonality accompanying an all F-16 fighter force, the decision was naturally tied in with whether the Fokker assembly line and other Dutch manufacturing should be continued. There was some discussion as to the option of continuing the Dutch line or buying these fighters off the General Dynamics line. The latter approach would reportedly have saved the Netherlands somewhere in the area of $150 million, or approximately $1.8 million per aircraft, and would also unfavorably impact an already severe unemployment problem (with the costs this involves). It now appears that Dutch production of the F-16's that will replace the NF-5's is the course to be followed.

(b) Belgium

Belgium was the second EPG country to decide upon follow-on orders for the F-16 involving a quantity of 44 aircraft. After heated competition with Dassault-Breguet for the replacement of the Belgian Air Force's older Mirage V, the Belgian Council of Ministers pronounced itself in favor of the F-16 at the end of July, 1982. A definitive commitment was not expected to be made until October, however. In the meantime, faced with very aggressive proposal effort by Dassault, GD had been forced to agree to very stringent conditions, especially in the area of offset.[250]

GD was forced to accept Belgian demands of 58% as previously in direct offset for the predominantly Walloon aerospace firms that were already heavily participating in the F-16 program. Furthermore, GD had to agree this time to 22% in indirect offsets for Flemish Industry in the north (primarily electronics).[251]

Delivery of the 44 new aircraft would begin in 1988. Payment of the $625 million would begin in 1986.

In making its decision the Belgian government once again had to deal with the Flemish-Walloon rivalry as it had in 1975, but with a new twist. At the time of the earlier competition the Walloons had supported the Dassault Mirage while the Flemish pushed for the F-16. But this time around the two groups reversed their positions as the Walloons were by then heavily entrenched in F-16 production, and Dassault came in offering substantial offsets to the Flemish who received very little of the F-16 work resulting from the first go around.[252]

Not only was the definitive October commitment missed but the linguistic-ethnic division continued to plague the project into 1983.

Belgian Council of Ministers was to meet on January 21 to decide whether to accept General Dynamics' latest offset offer.

Unless an agreement was reached, the Belgian economics ministry threatened to cancel the order.[253]

Even though the order had been agreed to in principle the previous summer, negotiations continued over how the offsets being offered by General Dynamics would be distributed within Beligan industry.

The Flemish aerospace group (FLAG) and other Flemish-speaking groups and government ministers were demanding that all the indirect offsets be high technology and go to Flemish firms. General Dynamics had no problem in agreeing to this in principle. However, they wanted to retain the option to place some of the indirect offsets in other parts of the country if Flemish industry was not interested in the particular offsets or not qualified to compete for the contracts. General Dynamics also expressed concern about definitions of high technology.[254]

(c) Denmark

The very week that Pratt & Whitney announced the termination of its one Danish subcontractor, DISA, at the end of 1980, the Danish parliament was considering a government request for a $250-million supplemental appropriation to the 1980 defense budget to help overcome cost increases caused by both infla-

tion, and the change in relative value between the dollar and the Danish kroner.[255]

Much of the appropriation, which the Danish parliament debated later in January, went to pay for the increased cost of the F-16 fighters (only seventeen of these having been delivered to date).[256]

The total 1980 defense budget of approximately $1.22 billion was passed by the Danish parliament in December, 1979, and was based on the price index calculated for January, 1979. Over the following year the country experienced an average inflation rate of about 17% and the value of the kroner had declined about 11% in relation to the dollar. Because of these factors, the Danes were facing a cost increase for all their defense purchases, and chief among them, the F-16. In dollar terms, however, Danish defense officials pointed out that the cost of the aircraft was still below the $6.019 million per aircraft price agreed upon in 1975.[257]

(d) Weinberger's Offer

As similar budget problems persisted in Belgium and Norway as well, all three nations held that they wouldn't be in a position to order additional aircraft until 1987. But the European production lines wouldn't last that long. Europe's 40% coproduction share of the EPG's original 348-plane buy, and its 10%

share of the U.S. Air Force's first 650 F-16's, were to run out before mid-1985. Additional F-16 sales to other countries were materializing but Europe's 15% share of such exports wasn't enough to keep production lines operating until work on 1987 follow-on orders could begin.[258]

Responding to this dilemna, Defense Secretary Caspar Weinberger made an offer to the EPG's in October 1982 that the U.S. would keep their firms working on the F-16 through the 1980s, at viable if not advantageous rates, if the four countries would commit themselves to follow-on buys totaling 209 aircraft. In addition to the Dutch plans for 111 additional planes, this entailed the above mentioned 44 for Belgium, plus 30 aircraft for Norway and 24 for Denmark.[259]

Specifically, the U.S. was offering front-loaded coproduction and additional, indirect offset in an effort to keep Europe's F-16 consortium together for the second half of the 1980s.[260]

The Pentagon was willing to front-load coproduction as an inducement to the Europeans because it figured they wouldn't order more F-16s if the production lines were broken and costs increased. With fewer planes in European air forces, the U.S. would have to provide more aircraft itself or accept lower levels for NATO.[261]

F-16 work in the Netherlands probably was secure through 1987 by virtue of Dutch follow-on orders already placed. Beyond its original 106 planes, the Netherlands had by this time ordered 54 of the additional 111 aircraft it had commmitted to buying.[262]

Belgium, Denmark and Norway had yet to make any such commitments. At the time the Dutch proceeded, the U.S. had been trying to keep follow-on production under the original five-nation memorandum of understanding. But the other countries, citing budget problems, had said they weren't ready. For this reason, the Dutch follow-on orders had come under a bilateral agreement.[263]

If the Europeans would commit themselves to placing these follow-on orders by 1987, the U.S. Government was offering to channel the appropriate amount of coproduction to their national industries during the mid-1980s in order to avoid broken production lines. General Dynamics and Pratt & Whitney have agreed to this provided that they were assured of getting in 1987 the aircraft and engine business with which the front-loaded, mid-1980s coproduction would be associated.[264]

In effect, European industry would wind up building a portion of U.S. F-16's during the mid-1980's and U.S. industry would build the European share of European F-16's at the end of the decade.[265]

General Dynamics and Pratt & Whitney had reportedly sweetened the offer further with an extension of the Belgian deal to the others for indirect, non-F-16 offset equal to about 22% of the procurement value of the follow-on orders. Coproduction was being offered in terms of equivalent shipsets but was being structured to provide the same 58% of European aircraft procurement value that applied to the first 348 planes. Coproduction plus offset would equal 80% of procurement value.[266]

Weinberger told the Europeans that the U.S. offer stood through the first quarter of 1983. Belgium had been negotiating with the U.S. and was reportedly near to closing the deal.[267]

The Dutch naturally wanted assurances that they wouldn't suffer from having moved to follow-on buys sooner than the other countries, and that their deal would turn out to be as favorable as the others'. The 22% indirect offset, and its applicability to the 57 planes the Dutch haven't ordered yet and the 54 they have ordered, was said to figure in this.[268]

Although Weinberger's offer was to last only through March 1983, officials speculated that it might be extended if a deal required only a little more negotiating time. They speculated, too, that participation by the Netherlands and Belgium, amounting to nearly three quarters of the follow-on aircraft total, might be enough to assure some sort of program regardless of what Denmark and Norway do.[269]

Pratt & Whitney's agreement on front-loaded corpoduction was said to be contingent on a minimum F100 order from the Air Force in FY 1986, the first year the service plans competition between the F100 and General Electric's F110 for substantial numbers of F-16 engines. Officials said the Air Force is considering whether to require GE to include provisions for European coproduction in proposals submitted under the engine competition. There is not such requirement in the draft request for proposals currently in circulation. An RFP is scheduled for release in March. Officials said the Air Force would try to avoid penalizing GE in its cost proposals if it requires coproduction provisions — the Europeans would have to finance F110 tooling, for example.[270]

20. Conclusions

A. The F-104G Replacement

A comparison of the mode of industrial collaboration utilized for the F-16 project with that of the F-104G's that it is replacing can be illuminating, vis-a-vis the evolution of NATO collaboration over the last three decades and some of the exogenous factors conditioning it.

The F-104G's were procured in a time frame when the U.S. and the FRG were collectively subsidizing the defense procurement of their European allies, be it in very different ways. This fortuitous combination was to be short lived in that the late 50's was both the tail-end of the heavy U.S. Military Assistance Program (MAP) funding of its NATO allies procurement (1949-1961), the less affluent Mediterranean states aside, and the front end of the FRG's rearmament/reintagration into the Western Europe community (picking up after 1955 and tapering off in the late 60's and early 70's). Along with this latter process, the FRG was willing to share the benefits of its large scale defense effort by selecting weapon systems and entering into work sharing arrangements that were favorably viewed, to say the least, and highly advantageous to their NATO allies.

The selection of the USAF Lockheed F-104 Starfighter, a lightweight air-superiority fighter, to be the baseline for a substantially modified multirole version of the fighter that could meet the Luftwaffe's requirements, along with the ensuing production sharing arrangements, was a major example of this. Of the F-104G's, 949 were built under license in Europe by a Belgian-Dutch-

German-Italian industrial consortium (Mode #2 of industrial collaboration) with the national lead firms contracting directly with their respective governments. The four government's aircraft orders broke down as follows: Belgium, 100 aircraft; the FRG, 700 aircraft (96 bult by Lockheed in the U.S.); Italy, 125, and The Netherlands, 120 aircraft. Though the key to the consortium was the FRG's large order and its desire to NATO-ize the program through distributing the work to any of its neighbors that could be interested in procuring the German 'G' variant of the F-104, the U.S. also provided major support. Belgium and The Netherlands each received MAP credits equivalent to 25 aircraft, while Italy received 50 aircraft-worth of credits.

The U.S. alone subsized the procurement of F-104G's by Norway and Denmark through MAP. As neither country had an aerospace industry they were excluded from the production side of the equation. (As we saw with the F-16 though, once they were footing the full bill, their electronics and mechanical industries would enter the picture, be it a smaller proportionate share than either Belgium or The Netherlands.)

Once the next generation system came under consideration in 1968, the FRG decided it would team as a full partner with its allies to design and develop a new multi-role aircraft from scratch (Mode #3 of industrial collaboration). By now the U.K. too had given up its unilateral approach to weapons acquisition and joined in as the other major partner in what was to become the Multi-role Combat Aircraft (MRCA) Tornado.

Though initially successful in enlisting all three of its F-104G partners, only Italy hung-in there. The Netherlands and Belgium could not justify

assuming the extra cost and risk associated with a project that would ultimately develop into a system heavily weighted toward the two medium powers concept of what was needed.

Therefore, The Netherlands and Belgium decided to wait several more years and see what was available on an off-the-shelf basis from other allied nations. Though missing out on the industrial benefits participation in design and development, through competition they could obtain a system more tailored to their own performance and cost range, while still participating in production. And, of course, this time around, they would have to pay the full cost and thereby deal with the increased pressure to assuage their constituents with the flow-back of some of the benefits resulting from these expenditures. This led to joining up with Denmark and Norway in 1974 to increase their collective clout through a buying government consortium that could ultimately be expanded to include a selling consortium including their respective industries. This time though, with the smaller scale of the project, production would be through the medium of subcontracts from the winning nation's prime contractor, not as licensee's fully responsible for delivery of the end item.

So much for the Mode of industrial collaboration utilized in procuring this system. Now, as for the choice to be made vis-a-vis to Project and Contract Management at the intergovermental level and in the area of the government-to-industry interface. As always, for projects that are not either of the bi-lateral licensing (Modes #1 & #4 of industrial collaboration) or bi-lateral offset (Mode #6) the choice was between that of setting up a NATO civil subsidiary agency outside of any national contracting framework, a NATO Production and Logistics Organizations (NPLO), or simply grafting a multi-

national organization onto that of the existing national framework of the lead country. Because of the overwhelming role of the USAF in the program and the decision to integrate production (i.e., European content not only in their own fighters, but those of the USAF and third countries), the latter was the logical solution. This can be contrasted with several other projects:

- the Boeing AWACS where the USAF and NATO projects (the latter with a large U.S. share) were separate projects at the customer and industrial levels (be there substantial overlap), led to the set up of an NPLO in Brunsum, the Netherlands; and

- HELIP where the existing NATO Europe NPLO (located near Paris) excluded the U.S., but for the Improvement Program still relied totally on the U.S. Army Improved Hawk Technical Data Package and Raytheon's system management and manufacturing know-how.

Like the NATO Seasparrow project involving originally the same four European nations plus Italy, a multi-nation steering committee was set up (be it with advisory not ultimate authority as with Seasparrow wherein it reported to CNAD and received NATO project states) and a multi-national staff at the relevant U.S. Procurement Command, the Air Force Systems Command (AFSC) Aeronautical Systems Division (ASD) in Ohio. The Procurement Regulations followed were those of U.S. DOD's ASPR, be they watered-down in certain areas, and the contract administration system of AFSC Contract Maintenance Division. In the latter case allowances were made for delegation per the usual working relationships with governmental contractor surveillance agencies in Europe.

B. Lessons Learned and Other Noteworthy Aspects of the Project

Here, I will attempt to enumerate only some of the lessons provided by the project and scattered throughout the project history.

1. Scheduling of Manufacturing and Subcontract Negotiations

The prime contractors had to substantially revise their initial scheduling of European production: both vis-a-vis manufacturing of hardware in line with the differing industrial relations environemnt; and vis-a-vis procurement in the area of purchase contract definitization where the standard terms and conditions become highly negotiable.

2. U.S. Government Responsiveness to Industrial Needs

In the latter case the U.S. contractors were highly dependent on the U.S. Government's responsiveness both in showing flexibilty where feasible and backing up U.S. industry where required. This involved both a rapid sorting out and working of problems by the SPO at both the intergovernmental level with the four EPG's and intra-governmental level with other components of the U.S. Government.

3. High Political and Media Visibility

These and other challenges listed below all have to be dealt with while working within a fish bowl; i.e., these projects involving several very sovereign allied nations are inevitably accompanied by high political and

media visibility. Not only do they find themselves at the center of a great deal of diplomatic attention, but domestic political debate as well. Examples include: the NATO RSI issue in the U.S.; the usual Walloon-Flemish squabling in Belgium; the choice of a major subsystem impacting standardization; the adequacy of the level of technology transferred; U.S. imposed contract terms and management systems; termination of a supplier for convenience or default; the distribution of work between the four ECP's.

4. Prime Contract Material Support Arrangements

Along with the NATO Seasparrow and NATO AWACS projects, this project offers additional examples of some of the complex prime contractor material support arrangements offered to foreign suppliers in an effort to alleviate the extra costs accompanying their participation.

5. Cost Premium for Second-Tier Subcontracting

On the other hand the project provides us with an example of some of the unavoidable cost premiums involved with second-tier subcontracting. A major share of the off-setting contracts to the EPI's were passed by GD's U.S. equipment and avionics subcontractors. The DCAS-approved mark-up or loading factored-in at this level by each firm proved to be significantly higher than at the prime contractor level, creating a substantial cost bulge whenever second sourcing via U.S. suppliers is required.

6. The larger scale of U.S. firms and their administrative systems tend to make them more of bureaucratic. The scale of the U.S. defense industry effort combined with the U.S. labor environment intensive production techniques means that our administrative and management systems do not flow down smoothly to smaller industries and firms in a more stable artisan-type employee environment. The U.S. systems tend to be heavy and bureaucratic when seen from the European view point. Though their is room for a discerning application of these U.S. systems by and large the foreign suppliers must learn to live with most of them, and in some cases even improve upon their earlier way of doing things (e.g., Quality Assurance systems). The U.S. firms themselves were also able to learn from the interchange, such as different approaches to resolving communications and manufacturing problems.

7. Program Management From 5,000 Miles Away

Not only the manufacture of subassemblies and components was second sourced to Europe, but final assembly and test (as with the NATO AWACS and HELIP projects). This placed some very critical demands on program management organizations of the prime contractor(s), and the communication systems set up to support them. Those set up by General Dynamics and Pratt & Whitney are outlined in the text.

8. Offsets

The offset element of an offer to sell major weapon systems to foreign governments will often eclipse the other traditional elements of a pro-

posal: performance, cost, and schedule. The offset battle that developed here was one of the most heated no doubt, but only a prelude to later inter-allied engagements where the F-16 was pitted against the Mirage F-1 and later the Mirage 2000, along with the MRCA Tornado and the navalized derivative of the losing YF-17 prototype, the F-18. Whatever the merits of a given system vis-a-vis cost, performance and schedule, once the buyer's order assumes a certain critical mass in required expenditures, offset comes into play and severely influences the final choice. Even after source selection is made, implementation of offset arrangements agreed to, along with their impact on the cost and schedule commitments continues to be a major part of project management. As for interpretation, there were some problems as in the German F-4 offset project before it. Though through precedent it is now easier to make offset definitions clear, it is hard to make them air tight. Of course simplicity helps.

9. Small-Tightly Knit Teams

As emphasized in Chapter 5 for one of the first NATO weapon system projects, the Atlantic maritime partrol aircraft, the formation of small tightly knit teams both within each government and between them, and thereby having the authority to drive through and enforce a consensus, is an imperative to successful management of inter-allied projects.

10. Synchronizing Contract Award and Agreementing on an MOU

The final MOU was agreed to and signed some five months after the award of the initial USAF prime contract through which it was to be implemented. Though this did cause some complications and uncertainty, they were minimal. The broad outlines of the MOU were known in January 1975 when contract award was made and, in most cases adequate provisions were made. This can be contrasted with the dilemma faced by another major inter-allied project in the same timeframe, the U.S. Roland where no MOU was originally even contemplated. One was actually signed in October 1975 nine months after the award, but there were cost increases and a major restructuring the following Spring, followed by a relaunch of the project.

11. Coming On-Board Late in a Sole-Source Environment

One example, however, of the problems that can arise from signature of the MOU sliding until after prime contract award, and then the LOA's taking almost another two years to sign, involved the Reliabilty Improvement Warranty provision. The U.S. Government was able to benefit from a competitive environment and negotiated favorable terms for itself. The EPG were not yet on board as there own source selection deadline had again slid, and had informally expressed no interest in obtaining an option. Once they had joined the project through the EPG's decision they wanted the provision but as they were now in a sole-source environment, they could only obtain the coverage at a substantially higher price than

the U.S. Air Force had paid, causing some ill will. The Europeans felt that the USAF had not adequately represented their partners' interests.

12. Configuration and Funding Trade-offs

a. The concurrency of full scale development and initial production in order to meet very tight delivery schedules made a difficult situation even more challenging. The U.S. contractors had to negotiate fixed price contracts with the EPI and commence transfer of the technical data packages and know-how for the start up of second source production while still dealing with a fluid design.

Though not a unique dilemma in the defense business, all parties concerned have to be cognizant of the difficult trade offs that ensue and be prepared to deal with them.

b. Ultimately, though initially complicating life for all concerned, especially at the inter-industry level, the program's multi-national character is credited with contributing to program stability and standardization of the design. In addition to the basic design-to-cost structure of the program, the need to put all changes out on the table for close cost scrutiny by the five nations (and a pro-rata assumption of cost by those that adopted them) tended to dampen the usual tendencies toward de-standardization.

c. Multi-national funding of the development and production in the case of this program, the largest in which the U.S. has ever partici-

pated, also contributed to funding stability in the U.S. In the MOU each country had to make iron clad commitments to assume full responsibility for any changes impacting the others, including the size of orders and scheduled deliveries. Though the Europeans ordinarily authorize funding for projects of this scope on a multi-year basis, in the U.S. this was not done up until the eary 80's. At one point when the U.S. Congress was seriously considering a slide in the program, but it was forced to back off because of this provison in the MOU.

d. When two or more armed services are involved in a joint project, whether they be of the same nation or not, there is bound to be some degree of de-standardization. The choice of an ECM system was the first major break within the original five air force F-16 team when Belgium opted for intra-service standardization over interservice.

e. The case of the selection of a new seat for the fighter on the basis of inter-service standardization which had not been previously coordinated with the four EPG (per the MOU) reminds one of the ever-present need for vigilance in inter-agency coordination.

13. <u>The DoD Fails to Standardize, but</u> . . .

Once again the USN and USAF could not reconcile their conficting requirements, each choosing opposing ACF prototypes. Even so, the U.S. aerospace industry has been able to offer a wider range of fighters in foreign competitions. In addition to the F-16, the F-18 has now been

adopted by three other allies, two of which are NATO members, Canada and Spain. The F-16 was not to win a NATO competition again until August of 1983 with the Turkish Air Force. With these two fighters we see that though the U.S. services failed to standardize, limited standardization has been achieved with allied Armed Forces. Between the two, over half of the NATO Air Forces are now covered. There is no doubt that these geo-strategic subgroupings within NATO will continue to color the quilt of the NATO forces. Unlike with the F-5 and F-104 a large percentage of our allies will now be operating fighters that also have a large place in the U.S. inventory (more like the situation with the F-4 and especially the F-86). It is ironic that the winner of the 1974-75 European competition was expected to have a leg up on any foreign competitors, but that the navalized derivative of the previously eliminated Northrop YF-17 prototype has since done so well in allied competitions. Moreover, this is representative of the inevitable patchwork of the alliance where there will continue to be a varying mix of inter-and intra-allied standardization.

14. FMS versus Direct Commercial

The GAO report on the F-16 project released in the spring of 1979 surfaced a fundamental issue; selling to foreign nations through the U.S. Government and its Foreign Military Sales (FMS) system versus the prime contractor entering into direct contractual relations with the foreign governments on a direct commercial basis. First there are the usual trade-offs: (1) Direct Commercial offers advantages vis-a-vis timelines and understanding, no FMS Administrative fee, a less detailed specifica-

tion and documentation, greater payment flexibility; (2) through FMS a foreign customer can benefit from the greater buying leverage of U.S. Government due to its large order base, technical and business management expertise offered by U.S. Government, and a more active sponsor in obtaining waivers on R&D recoupment and asset use charges, or receiving FMS credits (though not a prerequisite).

Though this is not necessarily an either-or choice (a given sale often being a mix of the two), in those cases where substantial sub-contracting with the foreign customer's industry enters the picture as the GAO report emphasizes, increased consideration should be given to the direct commercial approach. This would avoid the cumbersome process of obtaining waivers to the flow-down of DAR.

15. U.S. Shows Flexibility on Funding Terms

Even though the inter-governmental negotiation leading up to the four LOA's took much longer than expected, the U.S. Government in the end was able to show substantial flexibility, vis-a-vis payment schedules; waiving of the normal FMS cash advances required to cover terminations (though this presented other problems); deferred payment of R&D costs; and the U.S. Treasury's agreement to accept advanced payments.

16. Third Country Sales

The buying and making of weapon systems is a highly potent political issue no matter what countries are involved. Naturally, who these sys-

tems are sold to is subset of this very complex and volatile set of issues. Among the soverign NATO allies this issue presents an inevitable dilemma for joint projects. This is true whether the U.S. is involved or not. With a wide variance from nation-to-nation, and as governing administrations come and go, this will continue to be a controversial issue.

17. Models for Other Projects

In setting up this project a number of useful mechanisms were developed by the U.S. Government that might be considered as models for future projects: Capital Investment Incentives for contractors, the establishment of a Currency Clearing House to handle the multiple foreign exchange transactions; and revised patent infringement liability.

18. GAO Audit and Applicability of CAS

Another example of lack of prior inter-agency coordination involved the initial DOD waiver of Examination of Records by the Comptroller General and Cost Accounting Standards, whereas only the Cost Accounting Standards Board and the GAO had this authority. Once corrected and the requirement to flow down the clauses was reinstated in both contracts an impasse existed for several months.

Ultimately jont audit compromise arrangements were worked out in early 1976. At a meeting of the steering committee's Price and Audit Subcommittee in November 1975, the EPG's and EPI's agreed to accept application

of the CAS Standards then in effect (CAS 401-407). Such was not the case for new standards later enacted (CAS 408-415).

19. AQAP

Use of NATO's Allied Quality Assurance Publications (AQAP) went smoothly, though they needed to be supplemented in subcontracts with the EPI's with additional requirements for: non-conforming materials control; lower-tier subcontract controls; and configuration management/engineering change control.

20. Follow-On Orders

The orginal 348 aircraft order of the EPI was just the beginning, enhancements and follow-on orders have since entered the picture along with the usual standardization and offset trade-offs.

21. Timely Congressional Review

In April 1975 Congress was notified of a pending foreign sale but not the conditions of it contained within the MOU. Since Congressional perrogatives were significantly restricted once the sale was approved and the MOU signed, especialy because co-production was involved, the 1979 GAO report recommended that the MOU as well be submitted for review by Congress as soon as possible.

22. European Depot Level Maintenance Support for USAF F-16's

It is necessary to be aware of the constant danger of getting trapped in "the chicken or the egg" scenario such as occurred with the planning for a joint depot level maintenance and repair program. The USAF couldn't commit itself to using EPG depots until they were established and funded, while EPG's couldn't make the investment until the USAF committed to use them. Some of the problems faced in breaking out of this impasse were: EPI facilities were to be fully engaged in production through 1985 and had little capacity to accept repair work from USAF F-16's deployed in Europe in the interim; and the U.S. limiting of repair contacts to one year.

23. The European Program Group

In the aftermath of the loss of the four-nation fighter competition in mid-1975, France realized that its dual status within NATO had hindered its sales efforts with its allies, in spite of appeals for European solidarity and the need for greater intra-European cooperation. Consequently, later that year France elected to join with its other European NATO allies, but outside of NATO, in forming the Independent European Program Group (IEPG). The collective objective to be pursued was to promote greater armaments collaboration amongst the European members of the Alliance.

1 See Chapter 7 for this program history.

2 German Defense officials evidently followed the European fighter evaluation closely, primarily through contacts with their Dutch counterparts, and there was talk within the four nation consortium of seeking German partipation, but nothing ever came of it.

3 F-16 Lessons Learned Study, Defense Systems Management College, Fort Belvoir, Virginia, 22060, June, 1978, Enclosure (2), p. 4.

4 DSMC Study, op. cit., Enclosure 4, p. 20.

5 Ibid., p. 21.

6 Ibid., p. 23.

7 Ibid., p. 21.

8 Ibid., p. 22.

9 "U.S. had to Reestablish Offset Credibility," Aviation Week & Space Technology, May 2, 1977, p. 75.

10 Ibid.

11 Ibid.

12 Ibid.

13 Ibid.

14 Ibid.

15 Ibid.

16 Ibid.

17 See Chapter 5

18 See Chapter 7

19 See Chapter 5.

20 See Chapter 11.

21 SNECMA is a primarily state owned firm, Chief among SNECMA's minority share-holders is Pratt & Whitney, SNECMA's competitor in the contest with its F100 engine in the F-16.

22 Robert R. Ropelewski, "F1E Buy Urged for European Unity," Aviation Week & Space Technology, p. 21, 1975.

23 Ibid.

24 Ibid.

25 Ibid.

26 Ibid., p. 20.

27 Ibid., p. 21.

28 Ropelewski, op. cit., p. 21.

29 Ibid.

30 Ibid.

31 Ibid.

32 "The Saab JA37 Viggen in flight test; the 37E in the European contest," Interavia, 2/1975, p. 187.

33 Ibid.

34 The Anglo-French Jaguar had also been heavily marketed by British Aircraft (BAC) to Belgium alone back in December 1973 - January 1974, but dropped out of the picture in February when the 4-nation purchasing consortium was set up.

35 Interavia Air Letter, No. 7982, April 8, 1974.

36 Formerly known as Fairey, (as it was part of the British manufacturing group of the same name) the firm changed hands in the late 70's and is now named SONACA (Societe Nationale de Construction Aerospatiale).

37 Interavia Air Letter, No. 7993, April 25, 1974.

38 Interavia Air Letter, No. 7984, April 10, 1974.

39 "The Saab JA37 Viggen in flight test . . .," op. cit.

40 Robert R. Ropelewski, "Saab Revises Indirect Offsets in Latest Fighter Sale Bid," Aviation Week & Space Technology, March 31, 1975, p. 20.

41 Ibid.

42 Ibid.

43 Ibid.

44 "U.S. had to Reestablish Offset Credibility," op. cit.

45 DSMC Study, op. cit., Enclosure (4), pp. 1-2.

46 Ibid., Enclosure (4), pp. 29-32.

47 GD participates in Sub-Committees, but not in the Steering Committee.

48 "F-16 Advisory Unit." Aviation Week & Space Technology, May 2, 1977, p. 63.

49 Edward H. Kolcum, "Fighter Effort Tests Collaboration Concepts," Aviation Week & Space Technology, May 2, 1977, p. 45.

50 As quoted in DSMC Study, Enclosure (5), p. 11.

51 James A. Abrahamson, Brigadier General, USAF, Defense Systems Management Review, Vol. 1 No. 3, Summer 1977, "F-16-NATO's Military and Economic Cornerstone.", p. 21

52 Now called the Defense Acquisition Regulations (DAR)

53 Abrahamson, op. cit., p. 22.

54 "U.S. had to Reestablish Offset Credibility," op. cit.

55 DSMC Study, op. cit., Enclosure (4), p. 40.

56 Ibid.

57 Ibid.

58 Ibid., pp. 41-42.

59 Ibid., p. 42.

60 Ibid., pp. 43-44. (Specialty metals account for a very high percentage of the F-100 engine and a small percentage of the airframe.)

61 DSMC Study, Enclosure (5), op. cit., pp. 12-13.

62 Ibid., p. 13.

63 Ibid., pp. 14-15.

64 Ibid., p. 15.

65 DSMC Study, op. cit., Enclosure (4) pp. 33.

66 Ibid., p. 36.

67 Ibid., p. 46.

68 Ibid., pp. 33-4.

69 Ibid., p. 34.

70 Since 3rd country sales were non-existent at this time 15%· OX = 0.

71 DSMC Study, op. cit., Enclosure (4), pp. 34-5.

72 Ibid., pp. 35-6.

73 Offset options are naturally further constrained by the fact that significant portions of these elements are not candidates for contractor provided co-production, i.e. Standard Ground Support Equipment, Government Furnished Equipment (common to numerous USAF aircraft) together with the support of these elements; and, of course, the non-recurring costs.

74 DSMC Study op.cit., Enclosure (4) p. 34.

75 DSMC Study op.cit. Enclosure (5) pp. 26-29.

76 Ibid., pp. 8-10.

77 DSMC Study, Enclosure (5), p.3.

78 DSMC Study, Enclosure (3), p. 8.

79 Kolcum, Edward H., "Fighter Effort Tests Collaboration Concepts" Aviation Week and Space Technology, May 2, 1977, p. 50.

80 DSMC Study, Enclosure (3), p. 8.

81 Ibid.

82 Ibid.

83 Kolcum, op. cit, p. 57.

84 Abrahamson, op. cit, pp. 22-3.

85 DSMC Study, op. cit, Enclosure (3), p. 9.

86 'Belgium selects F-16 ECM System,' Aviation Week and Space Technology, August 6, 1979, p. 16.

87 Ibid.

88 Ibid.

89 Ibid.

90 'Concensus Sought on F-16 Electronic Jamming System', Aerospace Daily, September 27, 1979, p. 123

91 Ibid.

92 Ibid.

93 "Dutch Air Force in Acceptance of Pentagon's ALQ-131", Aerospace Daily, November 12, 1980, p. 48

94 Ibid.

95 Ibid.

96 Ibid.

97 Ibid.

98 Ibid.

99 Ibid.

100 Ibid, p. 49

101 "British to Use Internal ECM Systems", Aviation Week & Space Technology, January 26, 1981, p. 74

102 AFLC-AFSC memorandum of agreement, quoted from DSMC Study, Enclosure 5, pp. 45-6.

103 DSMC Study, op. cit., Enclosure 5, p. 46.

104 Ibid.

105 Ibid.

106 Ibid., p. 49.

107 Ibid., pp. 49-50.

108 DoD Report to Congress on Rationalization/Standardization within NATO, January, 1980.

109 Burchfield, op. cit. p. 3, Burchfield also recommended that STANAG 4107 be fully implemented.

110 Louis Kraar, "General Dynamics Struggles to Build a Plane for All Nations", Fortune, March, 1977, p. 186.

111 Memorandum for John W. Boddie Air Force member of DoD Contract Finance Committee, Col. Charles Elliott, Chairman. June 14, 1976, as quoted in DSMC Study, Enclosure (5), p. 21.

112 DSMC Study, Enclosure (5), pp. 21-22.

113 Ibid., p. 37.

114 Ibid., pp. 38-39.

115 Ibid., Enclosure (5), pp. 19-20

116 Ibid., p. 16

117 Ropelewski, op, cit., pp. 65-6.

118 DSMC, op. cit., Enclosure (4), pp. 46-7.

119 Ibid., p. 47.

120 Ibid., Enclosure (6), pp. 20-21.

121 Not only were estimates of cost by some of the bidders complicated by a lack of experience with RIW and new designs, but the possibility of European co-production further increased the risks. The suppliers could have to make and perform overhaul on units built in Europe.

122 DSMC Study, Enclosure (5), p. 22.

123 Ibid., pp. 23-4.

124 Ibid., p. 16.

125 Burchfield, op.cit., p. 5.

126 Robert R. Ropelewski, "Five-Nation Coproduction Under Way," Aviation Week & Space Technology, May 2, 1977, p. 66.

127 "Broad Logistics Support Plan Evolves", Aviation Week & Space Technology, May 2, 1977, p. 114 (hereafter referred to as "Support Plan").

128 Ibid.

129 Conversation in July 1980 with Lt. Col. Kehl, Director of the Multinational Office at the F-16 SPO.

130 Ropelewski, op. cit., p. 66.

131 "Support Plan", op. cit., p. 114.

132 Kehl, op. cit.

133 "Support Plan", op. cit., p. 115.

134 Kehl, op. cit.

135 "Need for West's Fighters Put at 6,000", Aviation Week & Space Technology, May 2, 1977, p. 73.

136 DSMC, op, cit., Enclosure (7), pp. 1-5, Ibid., p. 6 (June, 1978).

137 Ibid., p. 5.

138 Ibid., p. 6.

139 Kehl, op. cit.

140 "GAO Cites Intermediate, Depot Maintenance Concerns for F-16", Aerospace Daily, August 21, 1980, p. 291.

141 Ibid.

142 Ibid.

143 Ibid.

144 Kolcum, op. cit., p. 50.

145 Kolcum, op. cit., p. 49.

146 Kraar, op. cit., p. 186.

147 Kraar, op. cit., p. 184.

148 Abrahamson, op. cit.

149 "Europeans Ready Production Tooling, Aviation Week & Space Technology", May 2, 1977, p. 101.

150 Kraar, op. cit., p. 184.

151 Ibid., p. 186.

152 Aviation Week and Space Technology, "International Management Team Sets Quick Response Time Goal", May 2, 1977, p. 93.

153 The number of GD personnel at these resident offices turned out to be less than originally thought. GD found that it was better to maintain a small liaison force, while depending more on the use of a telex system for solving problems. As of mid-1978 the number of these representatives totaled 6.

154 Ibid.

155 Ibid.

156 Ibid.

157 Bulban, Erwin J., "Studies Pinpoint Cost-Saving F-16 Manufacturing Techniques", Aviation Week & Space Technology, May 2, 1977, p. 87.

158 Ibid.

159 Kolcum, op. cit., p. 50.

160 Burchfield, op. cit., p. 7-8.

161 Brown, David A., "Pilot Display Program Set", Aviation Week & Space Technology, May 2, 1977, p. 129.

162 J. Philip Geddes, "F-16 Coproduction: An Americann Point of View", Interavia, November 1979, p. 1091.

163 Ibid.

164 Ibid.

165 Ibid.

166 Ibid., pp. 1091-2.

167 Kraar, op. cit., p. 188.

168 Ibid.

169 as of April 1977.

170 $735M for the 4EPG's 348 F-16's and $101M for the USAF's 650 F-16's.

171 Spare modules are stocked, and instead of shipping and entire engine to the depot for repairs, only those modules needing repair are sent.

172 Geddes, op. cit.

173 Ibid.

174 Warren C. Wetmore, "F-16 Engine Partnership Plans Nearing Completion," Aviation Week & Space Technology, May 2, 1977, p. 115.

175 Ibid.

176 Ibid.

177 Ibid., p. 117.

178 European's Ready Production Tooling, Aviation Week & Space Technology, May 2, 1977, p. 99.

179 Geddes, op. cit.

180 Ibid.

181 Ibid.

182 Wetmore, op. cit., p. 117.

183 Ibid.

184 Ibid.

185 Ibid.

186 "P&W Attempts to Keep F-16 Engine Subcontracting Work in Denmark, Aerospace Daily, January 4, 1981.

187 Ibid.

188 Ibid.

189 "F-16 Engine Contract Terminated", Aviation Week & Space Technology, January 12, 1981, p. 21.

190 Ibid.

191 Ibid.

192 Ibid.

193 "P&W Attempts to Keep F-16 Engine Subcontracting Work in Denmark, Aerospace Daily, January 4, 1981.

194 Ibid.

195 "Fabrique Nationale Experiences F100 Engine Production Delays", Aerospace Daily, April 22, 1981, 300.

196 Ibid.

197 The EPI follow a 230-235 man days/year versus 250-255 in the U.S.

198 Burchfield, op.cit., p. 8.

199 Fabrique National (FN) is one of the few exceptions to this one-shift characteristic among the European subcontractors. FN works a two-shift day. As a result, there was little difference between the original Pratt and Whitney estimate of duplicate tooling and most of FN's tooling costs are therefore covered in its contract with Pratt and Whitney.

200 Kraar, op.cit., p. 188.

201 Kraar, op.cit., p. 188.

202 Burchfield, op.cit., p. 1.

203 Burchfield, op. cit., p. 5.

204 Based on figures offered in Ropelewski, Robert R., Aviation Week & Space Technology, "Five-Nation Coproduction Under Way," May 2, 1977, p. 59.

205 Ropelewski, Robert R., "Five-Nation Coproduction Under Way," Aviation Week and Space Technology, May 2, 1977, p. 65.

206 Ibid.

207 Ibid.

208 Ibid.

209 Kehl, op. cit.

210 Ibid.

211 Telephone interviews with General Dynamic's Blaine Scheideman, V.P. and Director of the F-16 Program, and Norman Day, F-16 Director of Materiel, April 1981.

212 Ibid.

213 Ibid.

214 Ibid.

215 Kraar, op. cit., p. 186.

216 Aviation Week & Space Technology, September 18, 1978.

217 Aviation Week & Space Technology, October 18, 1978 p. 18.

218 Comptroller General of the U.S., A New Approach is needed for Weapon Systems Coproduction Programs Between the United States and its Allies, GAO, April 12, 1979, p. 20. (hereinafter referred to as GAO 4/79) Arrangement A_2 is covered in greater detail in Chapter 3 under the NATO AWACS program.

219 Ibid p. 10.

220 Ibid p. 20.

221 Ibid p. 12.

222 Ibid p. 13.

223 Ibid, pp. 16-17.

224 Ibid, p. 17.

225 Ibid, p. 18.

226 Aircraft Forecast, 'General Dynamics F-16 Falcon', July 1982.

227 Defense Industry Report, March 20, 1978, p. 124.

228 "AF Plans no F-16 Design Changes, Congress Told", Aerospace Daily, June 22, 1978, p. 278.

229 "Europeans sign F-16 Contracts", Aviation Week & Space Technology, May 9, 1977.

230 "F-16, F-14, F-15 Procurement Plans Soar", Aerospace Daily, February 10, 1982, p. 217.

231 "Air Force Awards First of Two MYP Contracts for F-16", Aerospace Daily, January 27, 1982, p. 132.

232 "U.S. Policies Thwarting Third-Country F-16 Sales", Aviation Week & Space Technology, June 25, 1979, p. 25.

233 Ibid.

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235 Ibid.

236 J. Philip Geddes, "F-16 Coproduction: An Merican Viewpoint", Interavia, November 1979, pp. 1090.

237 Ibid.

238 Ibid.

239 Ibid.

240 Ibid.

241 Ibid., p. 1091

242 "Belgium to Barter F-104G's", Aviation Week & Space Technology, March 16, 1981, p. 18.

243 Ibid.

244 Ibid.

245 "Rep. Dickenson Praises Multinational F-16 Program", Aerospace Daily, April 17, 1981, p. 275.

246 Ibid.

247 Ibid.

248 Ibid., pp. 275-6.

249 Ibid.

250 Pierre De Vos, "La Belgique Doit Confirmer en Octobre son Choix en Faveur du F-16 American", Le Monde, juillet 1982, p. 22.

251 Ibid.

252 "Belgian Linquistic Divisions Threaten F-16 Order", Aviation Week & Space Technology, January 24, 1983, p. 22.

253 Ibid.

254 Ibid.

255 "Danes Ask Supplemental to Pay for F-16's", Aviation Week & Space Technology, January 5, 1981, p. 18.

256 Ibid.

257 Ibid.

258 "U.S. Offers Europeans Up-Front F-16 Coproduction, Offset", Aerospace Daily, January 21, 1983, p. 113.

259 Ibid.

260 Ibid.

261 Ibid., p. 114.

262 Ibid., p. 113.

263 Ibid.

264 Ibid.

265 Ibid.

266 Ibid.

267 Ibid., p. 114.

268 Ibid.

269 Ibid.

270 Ibid.

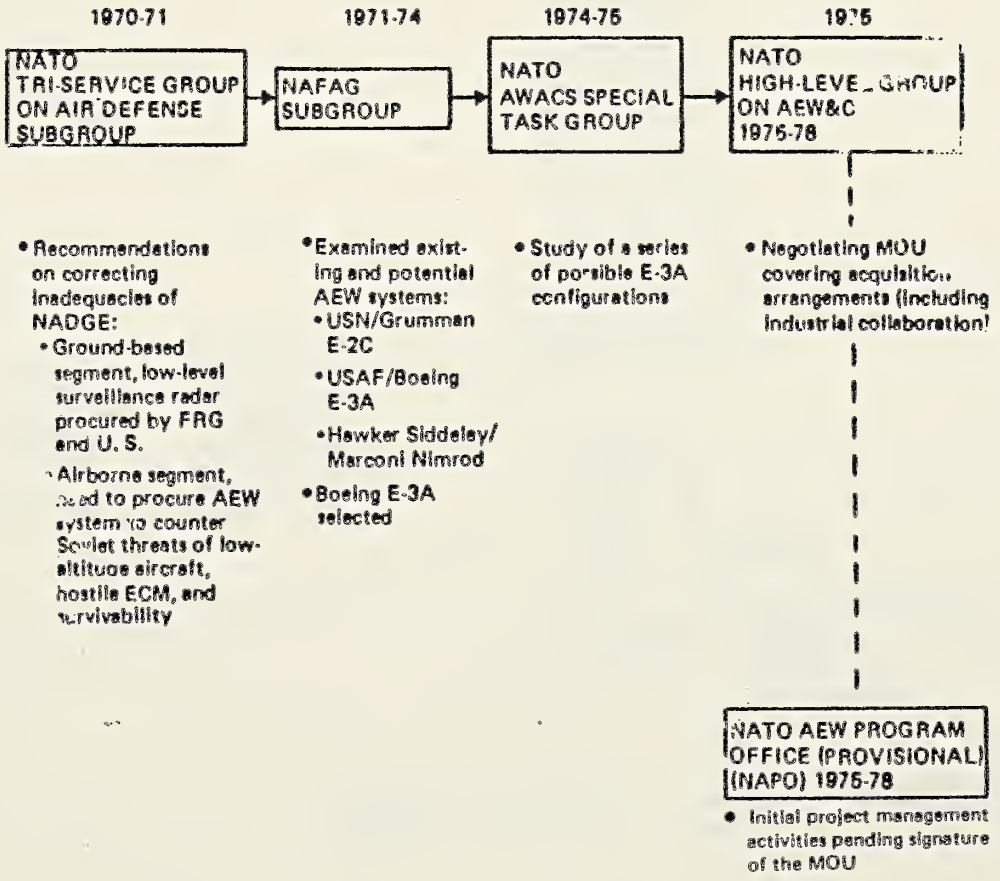
NATO AWACS

The project history on the NATO AWACS program has been withdrawn for revision. (See the Table of Contents plus the following charts for an idea of the prior 140 page version and where we left off.)

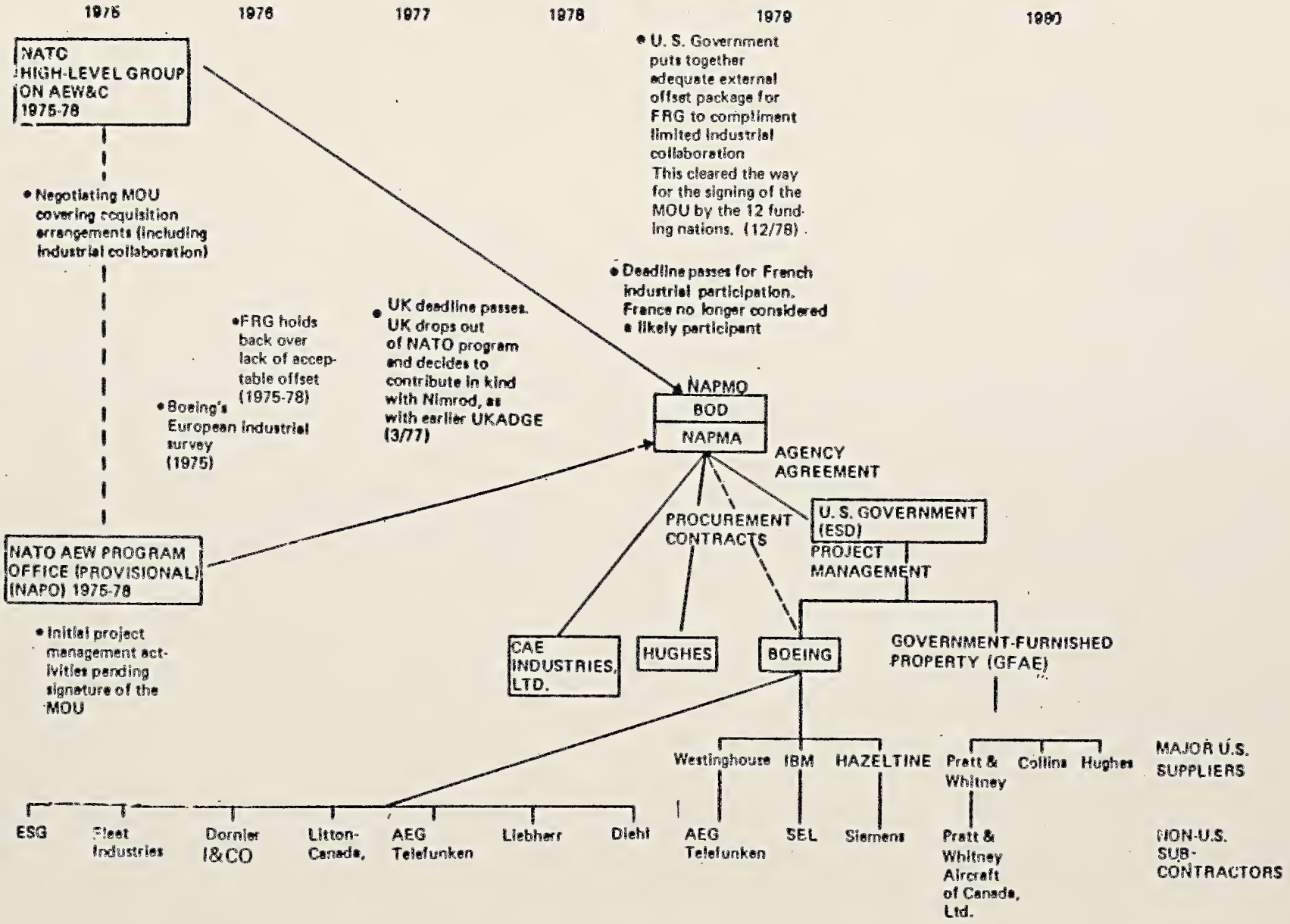

NATO AWACS
Canada*
U.S.
Participating governments
* Industrial collaboration
Independent national acquisition pending
Norway
Denmark
Netherlands
FRG*
Belgium*
Luxembourg
France
Portugal
Italy
Greece
Turkey
Black Sea

NATO AWACS Program (Part 1)

1970 - 1975



NATO AWACS Program (Part 2)
1975 - 1980



CHAPTER 13

MULTI-SYSTEM PACKAGE DEALS (MODE #8)

As was previously shown, in case of the U.S. MWDP funded NATO Lightweight Strike Reconnaissance (LWSR) fighter competition between 1955 and 1957, competitive common selection among prototypes of the selecting nations was unworkable amongst sovereign nations. Nations became so closely identified with their own prototypes that the final choice was ignored by the losing nations. As shown by the Atlantic, joint selection among competing designs instead of prototypes, couldn't do the trick either, involving no binding commitment of the losing nations to abide by the final choice in following it up with orders. In the case of NBMR3, over a major system, we saw that joint agreement on a final choice of design couldn't even be reached.

Where competitive common selection has succeeded for a multinational grouping of nations, it has involved very specific cases from which all the projects in Mode #7 emanated, and which all led to multinational offset agreements within U.S. led industrial teams. In the previous cases of the NATO LWSR fighter, the Atlantic, or NBMR 3, and the Franco-German tank project there had been no possibility of one body with sufficient authority arbitrating among the competing systems. This has been successful only where one participating nation had systems that could adequately fill the requirement, as occurred when the USAF intervened in selection of the Boeing E-3A over the Grumman E-2C by NATO for its Airborne Early Warning Program. Another case of joint common selection that worked was that between the Viggen, Mirage F1, and the U.S. winner of the YF-16/YF-17 competition by a consortium consisting of Belgium, Denmark, the Netherlands, and Norway in

the mid-1970's leading to joint production of the F-16. But here none of the selecting nations had their own national competing systems among the contestants. Yet other cases involved projects commonly funded by the NATO Infrastructure Program where the competing consortia each represented firms of all the major NATO nations such as NADGE (won by a Hughes led consortium in 1966) or SATCOM III Ground Stations (won by a Ford Aerospace led consortium in 1978).

The NATO LWSR project of the mid-50's followed by the joint Franco-German tank development project of the late 50's and early 60's collectively served to teach the NATO allies an important lesson - competitive common selection from among prototypes of the choosing nations was not politically feasible. Even when competition was reduced to the design stage, as exemplified in the Atlantic and NBMR 3 projects, it couldn't work, at least on an alliance-wide basis. Both of these were preceded as well by unsuccessful attempts to coordinate all armaments development and production within the alliance.

As things worked out, this issue was circumvented by the joint design/development and/or production arrangements seen in Modes #1-7. But the need still remains for a more rational form of collaboration in the development and production of weapon systems, one that allows for trade offs in work distribution on the basis of 'juste retour' to occur more rationally than within the framework of a single project.

This compromise between the extremes of the project by project approach that worked, but was costly, and the earlier attempts at alliance-wide solutions was found in an off-shoot of Mode #3 (European joint development and production).

This was the Anglo-French fighter package of 1965 and their helicopter package of 1967. A similar concept was developed in 1977 by the DOD, the "Family of Weapons" concept. This package deal/family of weapons approach offers the possibility of including many of the best elements of the other seven Modes, while eliminating many of their disadvantages. It also offers a feasible mechanism for bridging the gap between the U.S. governments 'interdependent' development policy[1] and the 'joint' development approach followed by Europe's three medium powers, France, the FRG and the UK (at least in those cases when unilateral development is not feasible).

[1]Interdependent R&D involves the unilateral funding and carrying out of a project within one nation, with tne end product being available to all partners to the agreement for license production. For technological, military, and political reasons this is generally not acceptable to the Europeans.

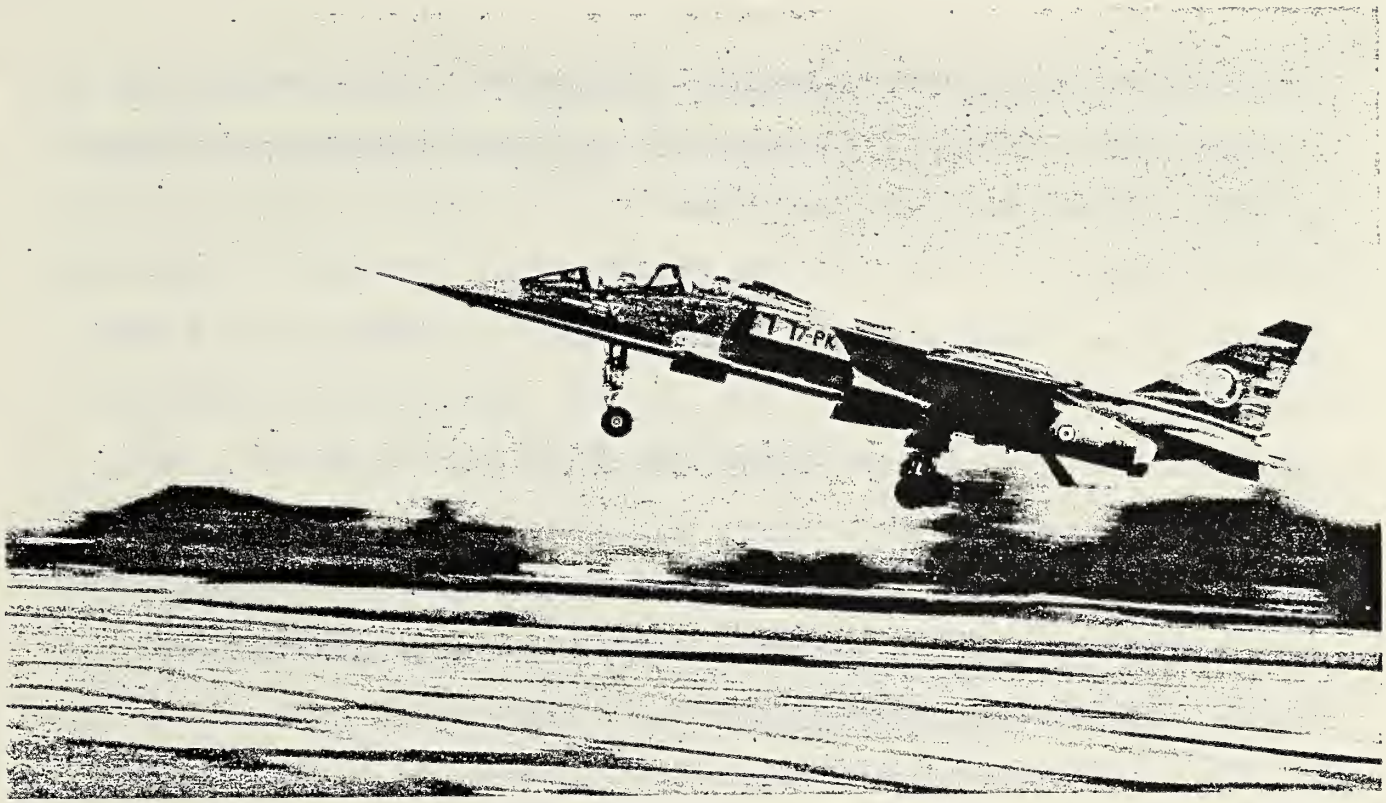
A. THE AFVG AND JAGUAR FIGHTER PACKAGE

In the wake of the cancellations and reorientation of the British government's aerospace policy in late 1964 and early 1965, on May 17, 1965 the British Ministers of Defense and Aviation and the French Ministers of Defense and Transport/Public Works signed an MOU covering the joint development and production of a variable geometry fighter for the late 1970's and a conventional-wing strike fighter/trainer. Each government committed $56 million to a design and production pool for the over-all program. Both governments were leaving the door open for other nations to participate; planning to inform other governments at appropriate times of the two projects needs and, if suitable inviting them to cooperate.[2] Anglo-French Projects Group was established at the intergovernmental level to oversee the two projects, each with its own Management Committee, and to later include other projects as added. The Anglo-French Martel air-to-ground missile project which had been launched the previous fall was the only other project to come within the Anglo-French Projects Group at this time.

Design work on both projects was started on the basis of a joint document outlining the French and British approaches to the operational requirements. The Anglo-French variable geometry (AFVG) fighter involved the collaboration of British Aircraft Corp. (BAC) and Dassault on development of the airframe and Bristol Siddeley and Snecma on the engine. The development of the strike fighter/trainer was to be based on the Breguet 121, and was named Jaguar. For the Jaguar the airframe partners were Breguet and, once again, BAC while Turbomeca and Rolls-Royce would collaborate on the development of the turbo fans for the two-engine aircraft.

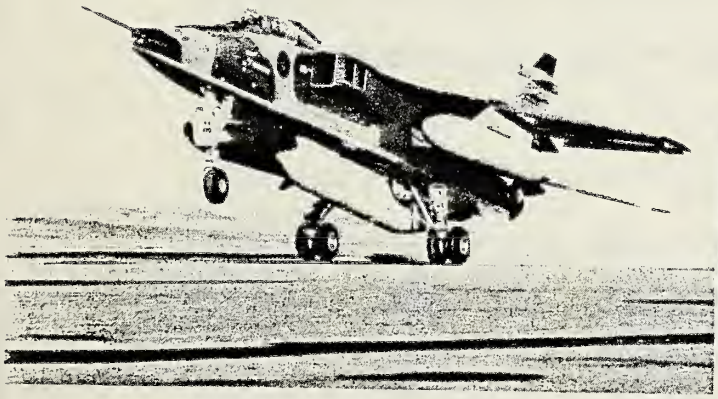
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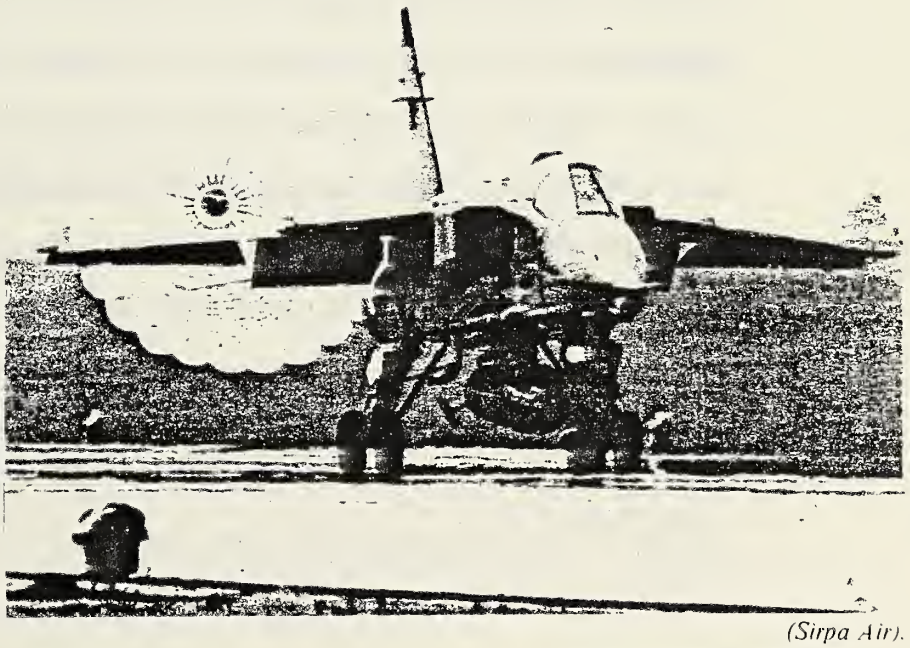
[2]Coleman, Herbert J. Coleman, "U.K., France Sign Aircraft, Engine Pact," Aviation Week & Space Technology, May 24, 1965, p. 18.



(ECPA)

N° 358 - Air Actu Février 83





The Anglo-French JAGUAR with a reconnaissance pod attached.
Photo by courtesy of BAC

(Sirpa Air).

N° 358 - Air Actu Février 83

As part of the same MOU both governments also agreed to a joint design study for an airbus concept, a joint evaluation on an early warning aircraft requirement, and specifications for a heavy helicopter.

The British and French governments were convinced that there would be a wide variety of uses for the variable sweep aircraft. Defense Minister Healey was quoted descsribing the project as "the core of our aircraft program". This aircraft for the British would replace the English Electric Lightning, and the Hawker Siddeley Buccaneer (both then in service), as well as the McDonnell F-4 Phantom recently ordered for the RAF from the U.S. The British requirement was for about 200 airplanes, against 150 for the French.

Unlike the Concorde supersonic transport project dating from 1962, the MOU contained a cancellation clause. Either nation could withdraw from either project, without financial penalty, by giving 12 months notice. However, until June 1, 1967 the planned date for a commitment of funds for full production, either side could withdraw from the variable-geometry aircraft without giving 12 months notice. The withdrawing government could be required, however, if the other government so desired to complete its work on the engine within agreed financial limits. Nevertheless, as was pointed out by Healey at the time, "We should not have entered into these agreements if we thought it likely that later we would withdraw".[3]

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[3] Ibid.

For the Jaguar strike fighter/trainer both governments would commit enough funds to enable the prototype stage of aircraft engine to be completed, with the intention of both governments being to then proceed to full production. The joint order for the Jaguar was expected at that time to be in the neighborhood of a total of 300 aircraft.

1. The AFVG Project

Within less than two months of the date of signing the MOU the fighter package was being threatened from within. Agitation had started behind the scenes to drop the Jaguar project all together from the package so as to be able to concentrate resources on the more advanced variable-geometry aircraft. This idea was being promoted by a small but powerful industry-government faction in both countries (the industrial part of which was those firms having nothing to do with Jaguar).

The move to drop the Breguet/BAC Jaguar had started in France in support of the argument that Dassault's sweep-wing design could be operational by 1971 using the Bristol Siddeley/Snecma Mars M-45G engine. The main complaint was that the work on the Jaguar project would tie up technical teams and production space that could be better used on the more spohisticated design for a variable-geometry fighter based on the design then underway at Dassault. Bristol Siddeley was particularly anxious to spur development of the Mars engine family because of its potential cross-feed into the civil market in view of the current talks between the engine manufacturer and Lockheed and North American on short-to-medium range

[4]"Move to Drop Brequet 121 Started," Aviation Week & Space Technology, July 19, 1965, p. 24.

jet transport projects. In any case, this attempt to dump the Jaguar failed and the two fighter projects continued in tandem.

By October 1965, BAC and Dassault had reportedly produced a joint design for the variable-geometry fighter that was considered fairly definitive. The emphasis then turned toward completion of engine specifications by the Joint Engines Subcommittee of the Anglo-French Management Committee.

Over the following year, however, the projects prospects were reversed as the French resistance to rising research and development costs stiffened. The joint specifications effort was faced with the difficulty of reconciling the two versions required by the two nations. The British wanted a long-range strike aircraft and the French, an interceptor with the capability of supersonic speeds at high altitudes.

By October 1966, the variable-geometry fighter was considered near cancellation by both governments. Both BAC and Dassault were preparing to resubmit their design in an attempt to cut costs. The crucial decision on development of the AFVG, then in an advanced stage of design was to be decided at a Defense Ministers in November, 1966, but was delayed until December. The French delegates indicating a necessity for a hard look at French defense budgeting into the early 1970's, while the British were pressing to go ahead. The Ministers ordered BAC and Dassault the complete specifications of the airframe and engines before the December meeting, while financing discussions continued at a political level.

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[5]"Variable-Geometry Fighter Decision Set for December," Aviation Week & Space Technology, November 14, 1966, p. 32.

Although the two nations' requirements were different technically, the British felt that there was no insuperable obstacle to harmonizing the requirements.

The planning at that time envisaged the two nations sharing jointly in an estimated R&D cost of about $560 million. As a result of France's concentration on building up her nuclear forces, however, particularly the submarine segment, there was a shortage of funds for conventional armaments. This expenditure was the crux of the problem for the AFVG.

Healey was committed by the decision made the previous year, when he told the House of Commons that the AFVG fighter would be the operational and industrial core of British air strike power in the 1970's. In order to lessen the French resistance to the program, the British were offering th carry more of the financial load, preparing to take the first 50 airplanes off the joint production line in 1972. The French would not begin to take theirs until 1974, thus reducing the pressure on the French budget.[6]

In December, however, once again no decision was reached, while the chances for any formal or definitive action on the AFVG, in the near future, dimmed. Industry fears that France was about to pull out of the AFVG program grew as British Aviation Minister Mulley stated "we are well advanced in contingency planning".[7]

When the two Defense Ministers met again in April 1967, as the production-commitment deadline of June 1 neared, they decided to postpone the production-commitment by 18 months, until January 1969. The development of the design was

[6]"UK-French Effort Seen in Doldrums," Aviation Week & Space Technology, December 12, f1966, p. 33.
[7]Ibid.

to continue on schedule with the aircraft still being planned for 1974 service. At the same time, the two governments formally asked the FRG to participate in the program, either through outright purchase, or preferably entering the consortium on a work-sharing basis. A German decision was not expected until mid-summer.[8]

Several months later, in late June, the joint variable-geometry aircraft project finally collapsed. The French government formally withdrew, notifying the British government that it would not be able to meet its financial commitments in the AFVG program, while the British decided to proceed with a project definition study of its own version of the AFVG.[9] Evidently, even though the two governments had been able to reach full agreement on both operational and production requirements, the French Government decided - barring a complete change of timetable and operatinal requirements - to withdraw from the program.[10]

Defense Minister Healey quickly clarified its position on the issue of the impact of the French decision on other Anglo-French joint military projects, saying that (i.e., with regards to the Jaguar and more recently, the Westland-Sud helicopter projects) there would be no repercussions.

With Britian left high and dry, the opposition Conservative proceeded to exploit the issue. The shadow defense minister attacked Defense Minister Healey and called for a full debate on "the wreckage of the government's defense policy".

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[8]"Anglo-French Fighter Decision Postponed," Aviation Week & S½pace Technology, April 24, 1967, p. 26.

[9]"French Drop AFVG; U.K. Continues Effort," Aviation Week & Space Technology, July 10, 1967, p. 32.

[10]"AFVG ABandonment," Aviation Week & Space Technology, July 3, 1967.

He claimed that Healey could not "disavow responsibility for having made up an airplane that will not come into existance, a gamble that did not pay off".[11]

As for British industry, in addition to the anxiety caused by the collapse of its major military aircraft project for the following decade, the unbalanced nature of the Anglo-French joint project packages (the remaining half of the Anglo-French fighter package and the recently established Westland-Sud helicopter package) was glaringly evident. Of these four remaining projects, French industry was in the position of design leadership in three.[12] The cancellation also left no immediate military use for the Bristol Siddeley/SNECMA M-45 powerplant, which was under development for the AFVG (the M-45 was later selected to power the ill-fated VFW 614 transport).

The possible implications of this vis-a-vis the maintenance of the technological strength of the British aerospace industry and of a concommitant freedom of action for future joint projects was readily appreciated.

The French, who had continued to fund their simpler Mirage 3G variable-geometry fighter (an aircraft at a more advanced stage development) in parallel with the AFVG program, as a back up alternative, continued for several more years with the funding of the development of its Dassault variable-geometry aircraft (redesignated the Mirage G6, and then later in a scaled down version, as the Mirage G8). This seperate R&D program, however, finally reached a dead end in the early 70's, never having been ordered into production.

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[11] "French Drop AFVG...," op. cit.

[12] Herbert J. Coleman, "U.K. Stressing Collaborative Efforts," Aviation Week & Space Technology, September 7, 1970, p. 14.

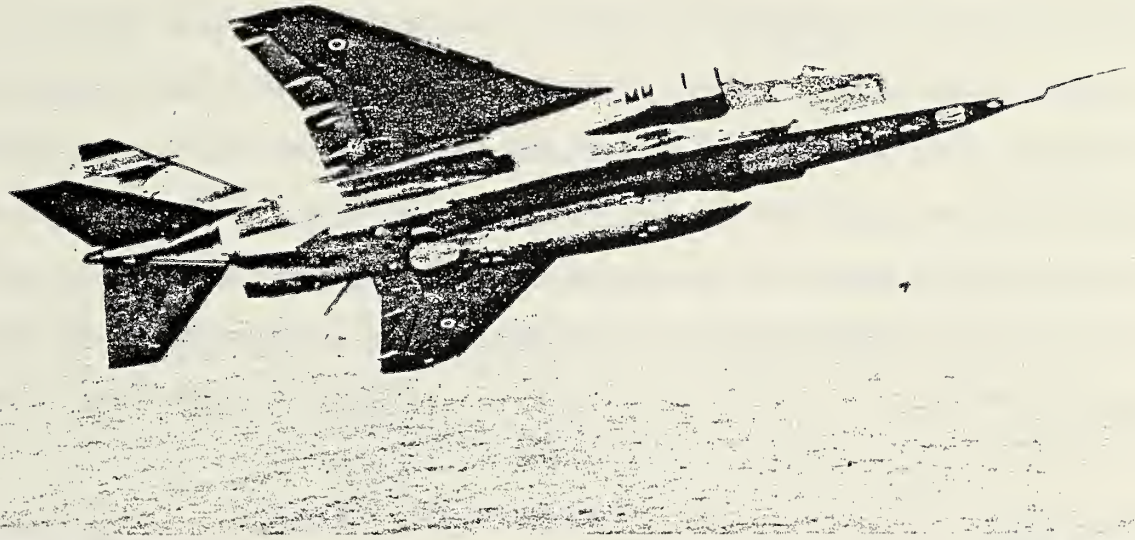
For their part, the British government had been considering the alternatives of: an all British variable-geometry study; increasing its order for 50 General Dynamics F-111 variable sweep aircraft by as much as another 100; joining the U.S.-FRG/STOL fighter program, or the possibility of collaboration on a variable-geometry program with other countries. The latter alternative was the one finally taken in the following year and resulted in the Anglo-German-Italian MRCA program.

2. Jaguar

(A) Establishment of the Program

The Jaguar tactical strike and advanced trainer aircraft is the result of the independent requirements of the Armee de l'Air and the RAF. For France, the Jaguar concept dates from 1964 when the French Air Staff was interested in a new light multi-purpose aircraft which could serve in both tactical support and advanced trainer roles and would be a link between the Magister and the Mirage III and which could replace the F-84, T-33, F-100 and Mystere IV. Breguet Aviation won the subsequent technical competition among French airframe constructors with its BR.121 for the requirement known as the E.C.A.T. (Ecole do Combat et d'Appui Tactique).

The engine chosen was a joint submission by Rolls-Royce and Turbomeca. Simultaneously the British Air Staff was thinking of replacing the Gnat, F-4 Phantom, Hunter, and Canberra by 1970 and of equipping its forces with a supersonic training aircraft. It therefore studied the requirement for an advanced aircraft



(Photo Sgc P. Georges).



that could carry missiles, but found it too expensive to continue such research alone. Since the British Air Staff had a high opinion of the Mirage, Mystere and Fouga-Magister and was in close contact with the French Technicians, it studied the BR.121 in detail and came to the conclusion that, slightly modified, the aircraft would meet British requirements. "As such the British aircraft industry, the most highly developed in Europe, was in effect, given an aircraft to work on."[13]

As a result of the similarities of their two requirements, the two countries agreed to synchronise their programs for the multi-purpose aircraft and thereby produce a considerable saving in development and construction costs. By April 1965 British and French operational and technical experts had agreed on a common requirement. On May 17, the Defense Ministers of the two nations signed an MOU that established the basis of the joint program as part of the package also including the Anglo-French variable geometry (AFVG) fighter.

British industry, in this case BAC for both projects, was willing to abdicate design leadership on the Jaguar since it was being compensated by what it expected to be a lead role in potentially much more significant project, the AFVG. The name Jaguar was chosen for the strike/trainer aircraft, satisfying the requirement of all such names for Anglo-French projects, that the word be the same in both languages.

BAC was designated by the British government as Breguet's partner to come up with the final design, develop and produce the Jaguar. Within each collaborative

[13]Elise Novel, NATO letter, July/Aug 1968, pp. 10-11.

team, the aircraft manufacturers and the two engine manufacturers, work would be divided equally between the two nations firms. In November, 1965, Breguet and BAC submitted a design proposal based on the Breguet 121. The design was frozen the following spring.[14] The time lost in harmonizing the two requirements is estimated to be about four months. However, because these two requirements were similar no extreme compromises were necessary and it is expected that the result will actually be a better aircraft.*

(B) Organization

On the intergovernmental level, under an Anglo-French Projects Group (overseeing all Anglo-French projects), comes the Anglo-French Jaguar Management Committee. This Management Committee is comprised of government and military members representing both countries. It is assisted by four subcommittees which are: the Airframe Technical Subcommittee, the Engine Technical Subcommittee, the Production Subcommittee, and the Administrative Subcommittee.

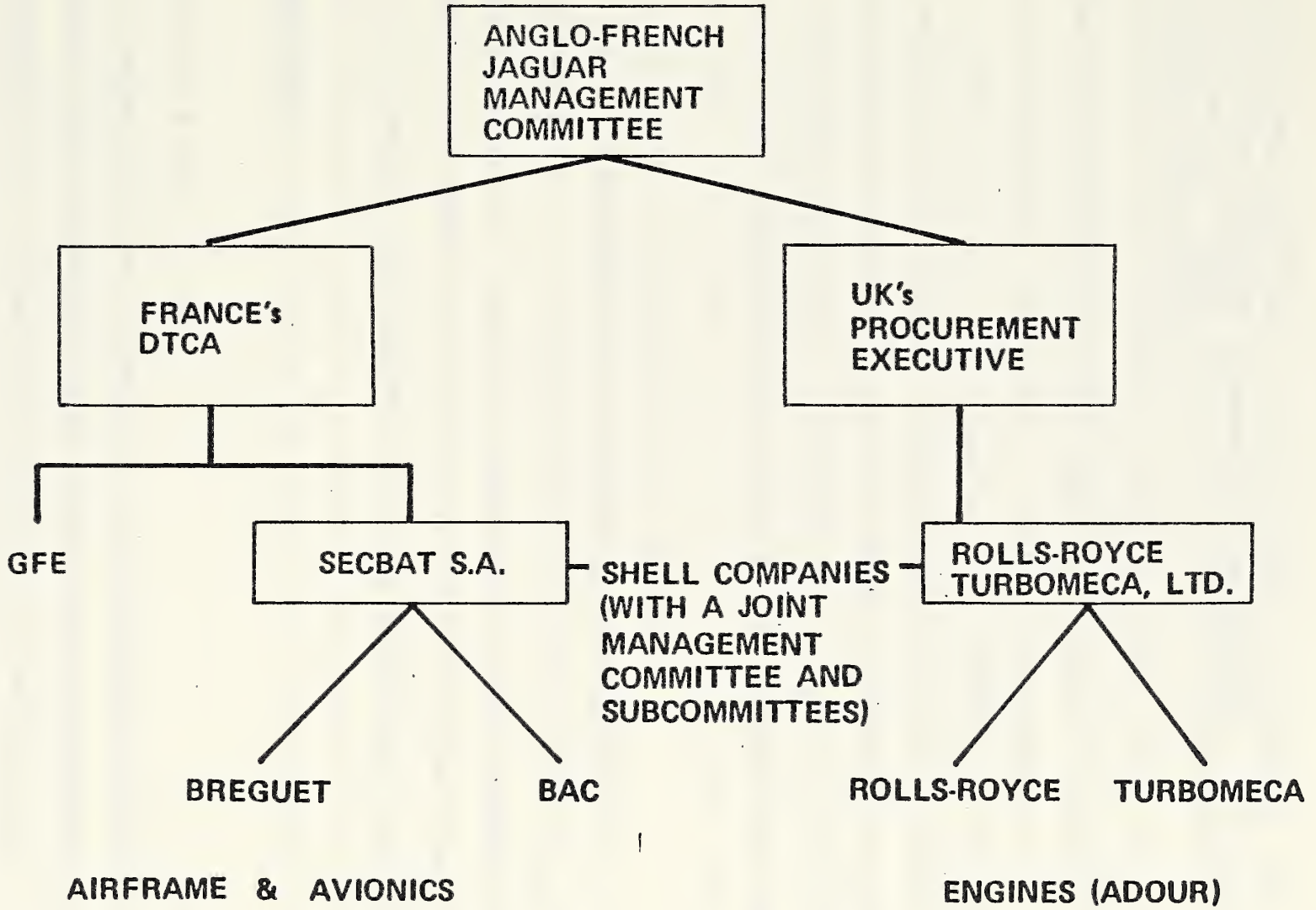
Drawing on the earlier experience gained from the Concorde program (dating from 1962), the governments had decided at an early stage that there would only be two contracts, one for the airframe and one for the engine. It was agreed that the French government would act for the British government in placing the contract for the airframe, and the British government would act for the French government in handling the contract for the engines.[15] The two airframe manufacturers established a joint company in May, 1966, SEPECAT S.A. (Societe' Europeene de

[14] Aviation Week & Space Technology, May 16, 1966.

* Edward H. Kolcum, "U.K., Germany Vie for Lead in Advanced Fighter Effort," Aviation Week & Space Technology, September 16, 1968, p. 91.

[15] A. H. C. Greenwood, RUSI Journal for Defense Studies, July/September, 1972, p.8.

Jaguar


ANGLO-FRENCH JAGUAR MANAGEMENT COMMITTEE
FRANCE's DTCA
UK's PROCUREMENT EXECUTIVE
GFE
SECBAT S.A.
SHELL COMPANIES (WITH A JOINT MANAGEMENT COMMITTEE AND SUBCOMMITTEES)
ROLLS-ROYCE TURBOMECA, LTD.
BREGUET
BAC
ROLLS-ROYCE
TURBOMECA
AIRFRAME & AVIONICS
ENGINES (ADOUR)

Production de l'Avion d' Ecole de Combat et d' Appui Tactique) registered in France and governed by French contract law. The two engine manufacturers likewise established a joint company Rolls-Royce Turbomeca Ltd., but in this case registered in the U.K. and governed by British contract law. In both cases the firms were equal shareholders. SEPECAT S.A. signed a contract with the French government's Direction Technique des Constructions Aeronautique (DTCA) and Rolls-Royce Turbomeca Ltd., signed a contract with the British government's corresponding agency, both then subcontracting the work to their industrial shareholders. Both companies were only corporate shells, mechanisms established for the contracting and sub-contracting of the work. As corporate shells, or holding companies, they are without any staff of their own, drawing instead upon the facilities of the parent companies. Both companies have a Board of Directors, with the Chairmanship alternating between the respective firms. Both also have a Management Committee below the BOD consisting of four subcommittees for coordinating the activities of the respective firms engineering project management, production, finance, and sales. The use of a single corporate entity, the result of progression from the Concorde to the Jaguar has been declared to "...have worked very satisfactorily by the participants."[16]

> A 1972 Aviation Week Space Technology described DTCA's contracting and project management approach to the Jaguar. "SEPECAT's production contract with the French government involves fixed prices for fixed starting dates, with only limited room for negotiating for unforseen costs. There is, however, an escalation formula called, fixed definitive, and fixed revisable, the latter to cushion effects of the former in case of unforseen economic events, (that is in those areas for which the contractor has no control, the usual inflationary/ exchange rate effects on the prices of wages and components). There was also some cost-plus work available, but it applied only to the flight test program, and then only when a cost item - such as increased manhours due to flight test results were not forseen."[17]

[16] Ibid.

[17] Aviation Week & Space Technology, September 4, 1972, p.53.

"Due to a French concern early in the program that the Jaguar design (essentially the Breguet 121) could be escalated beyond the projected financial capability by over-design or preoccupation with areas beyond the state of the art, extremely tight French contract procedures were applied that effectively blocked any such inclinations. The French placed continuous pressure on the joint program towards minimizing design modifications and freezing the design as early as possible so as to avoid jeopardizing the production schedule of cost."[18]

"This basic French directive led to a management structure in which the project manager system is carried into each main facet of the Jaguar design, manufacturing, flight test, weapons systems development, production, and product support -all reporting to their respective firms project manager who coordinates with his counterpart of the partner firm through the Engineering Project Management Subcommittee of SEPECAT's Management Committee."[19]

(C) Work Sharing

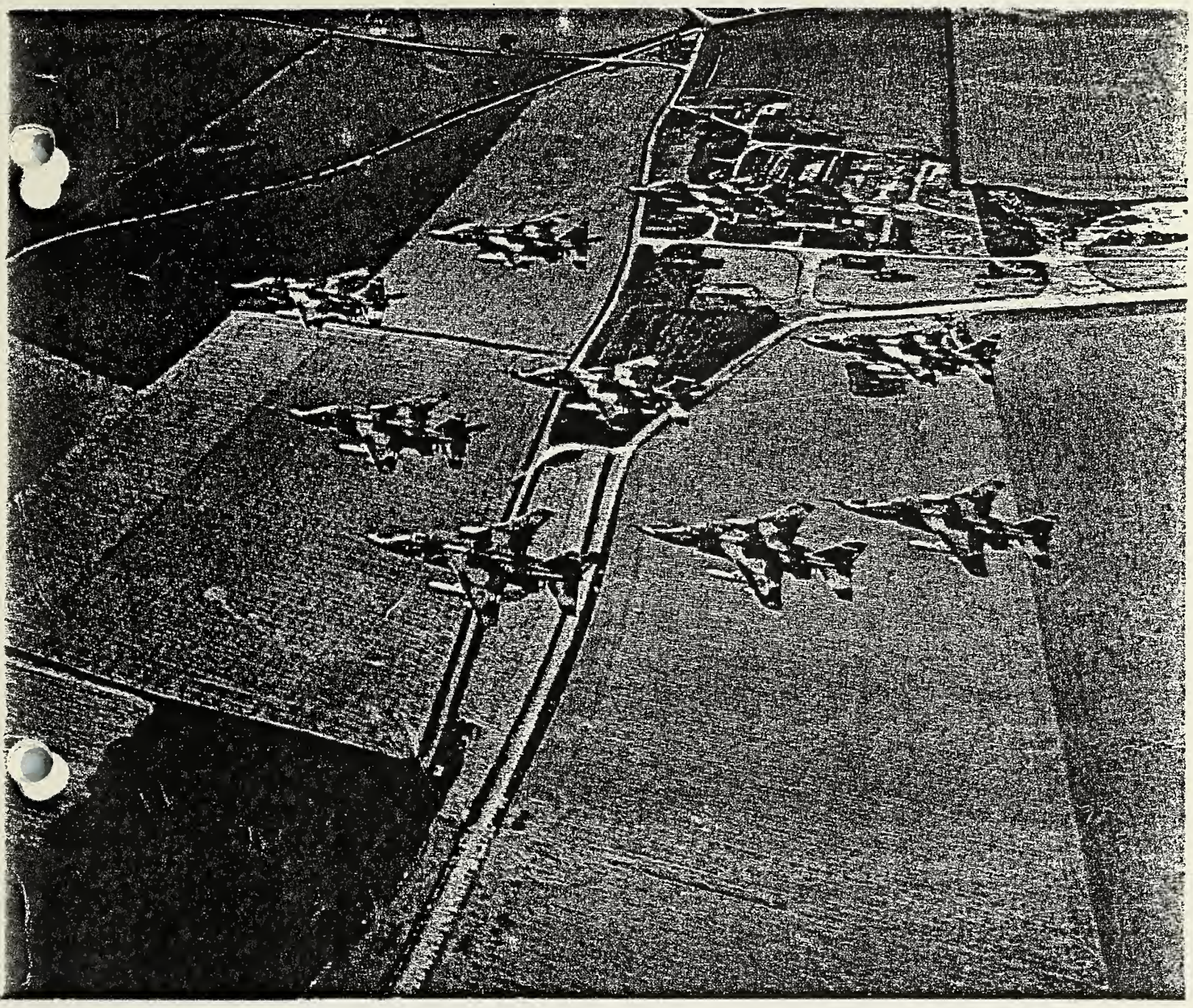
On the airframe side, development and production is equally divided between the two nations firms, following the natural breakdown into subassemblies, with every effort having been made to avoid duplication in the production process. Breguet builds the nose, the center fuselage, and the cockpit. BAC builds the rear fuselage, the wing and tail assembly, and fits the engine. Dual final assembly lines were set up in both the U.K. and France with the appropriate airframe sections being shipped from one country to the other. Each country assembles the aircraft for its own air force. Assembly for other countries can be handled by either Breguet or BAC.[20]

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[18] Ibid.

[19] Ibid.

[20] John Marriott, "Anglo-French Cooperative Ventures," NATO's 15 Nations, October/November 1976, p.78.



Jaguars are in squadron service with the Royal Air Force (above) and the French Armee de l'Air.

worldbeaters

JAGUAR –low-level tactical strike and reconnaissance aircraft built by BAC and Dassault/Breguet

CONCORDE –supersonic intercontinental airliner built by BAC and Aérospatiale

TORNADO –multi-role combat aircraft built by BAC, Messerschmitt-Bölkow-Blohm and Aeritalia

RAPIER –ultra-low-level missile air defence system built by British Aircraft Corporation

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On the engine side, the development contracts for the Adour engine was divided about equally between Rolls-Royce and Turbomeca. Rolls-Royce designed and manufactured the combustion sections, turbines, afterburner, fuel control, fuel pumps and accessories. Turbomeca is responsibile for the design and manufacture of the compression stages, the engine canopy and the gearbox. Each company also builds the accessory packages for its share of the engine and each also has its own assembly line.

Development costs for both the aircraft and its engines are shared equally by the British and French governments. The total estimated extra development and production costs compared to a purely national program were estimated as between 40 and 50 percent, but as such, only cost each individual country about 70-75 percent as much as if they had each gone it alone.[21]

(D) Roles

Each country has procured its own version of the single-seat tactical support aircraft and the two-seat trainer. Since both nations and both missions involve many common characteristics, requirements were similar, no costly or dangerous compromise was needed.

[21]Kolcum, op. cit. Another estimate of this collaborative premium/individual national cost savings was offered entitled "European Security: 1972-80" published in the April, 1972, issue of the Royal United Services Institute (RUSI) for Defense Studies, p. 148. The numbers cited by Brown were one third less on R&D and perhaps 10-15% less on individual machines than they would have on a unilateral project.

The Jaguar is designed to undertake four major roles in all:

- Battlefield operations in support of ground forces;

- Interdiction operations over the battlefield and beyond;

- Reconnaissance over the battlefield and beyond, and;

- Advanced operational conversion flying training.

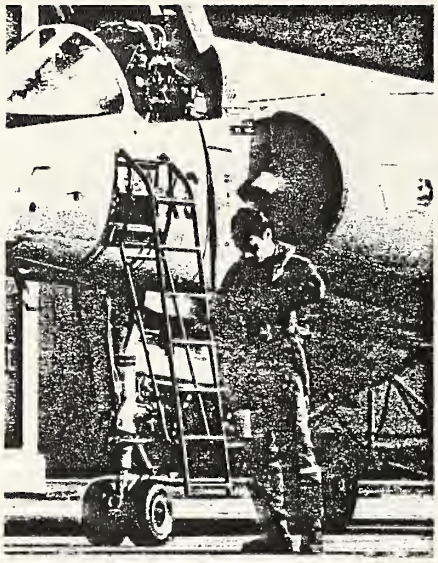
Four versions were built for the two nations:

- The E-model, which is a two-seat advanced trainer, for the l'Armee de l'Air, with two DEFA guns, an independent gyro gunsight, and a twin gyro platform;

- The S model, which is a single seat tactical fighter for the RAF, with two Aden guns, an inertial platform with a digital computer and a heads-up display, and a laser rangefinder;

- The A model, which is a single-seat tactical fighter for the l'Armee de l'Air with two DEFA guns and a doppler/twin gyro with a navigation and bombing computer;

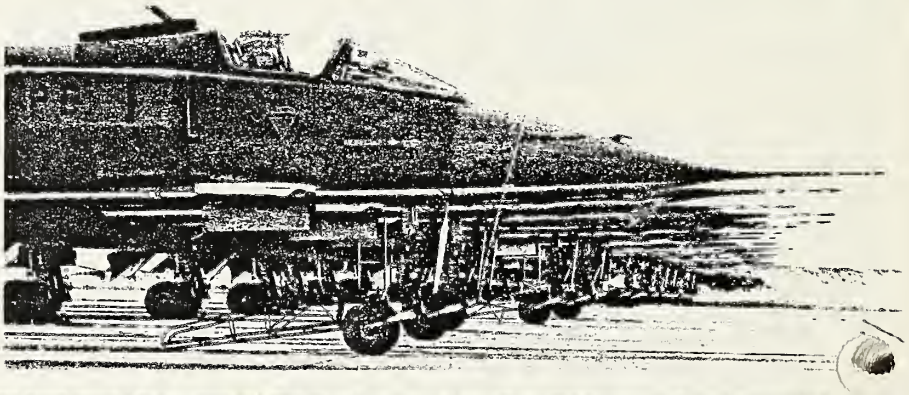
- The B model which is a two-seat operational conversion trainer for the RAF,with one Aden gun, an inertial platform with a digital computer and heads-up display, and;

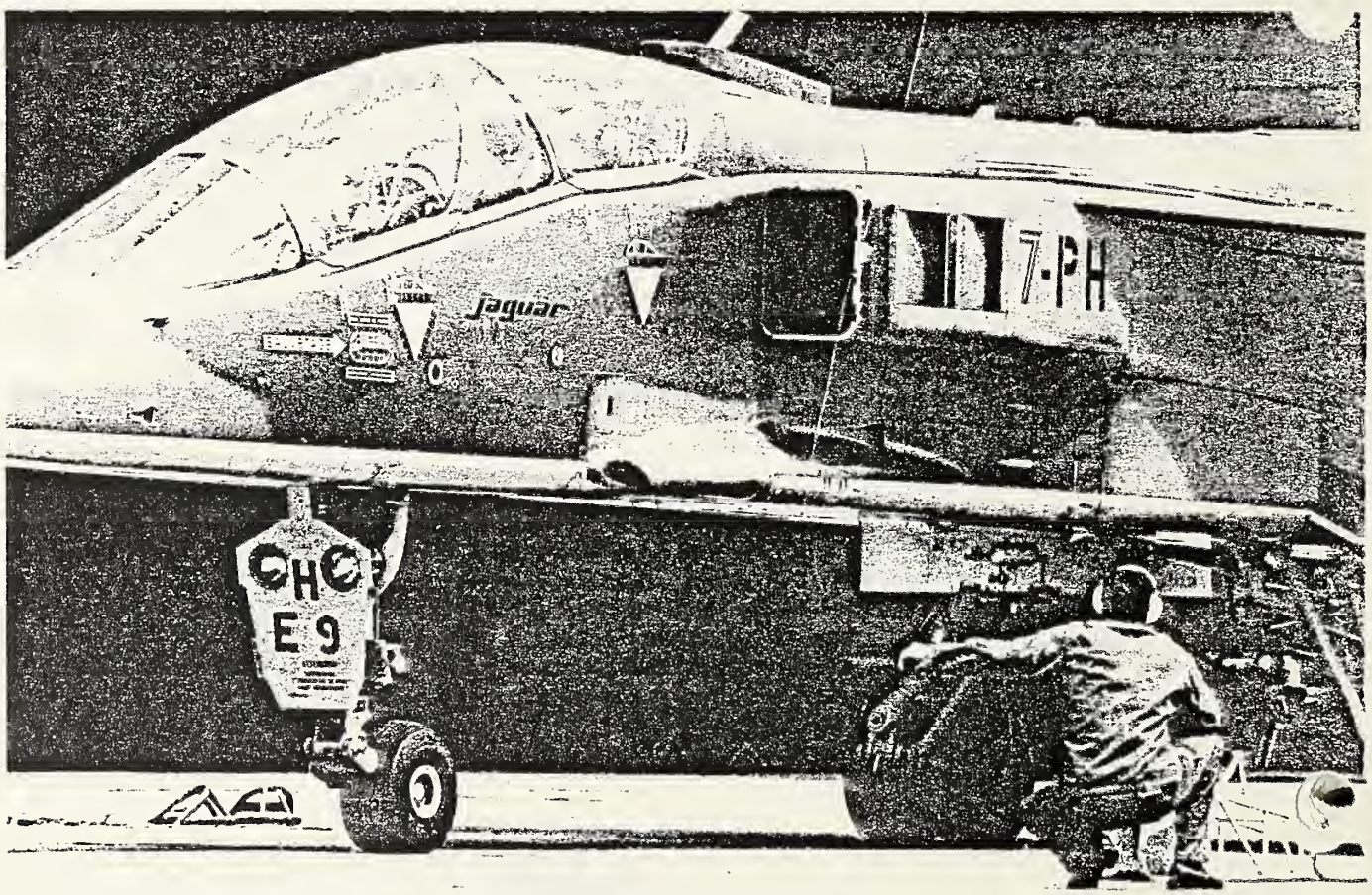




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- The M model which was a lighter single-seat attack aircraft with different landing gear for the French Navy's carriers was cancelled due to its being too heavy and too expensive. Instead they went ahead with the development of the all-French Super Etendard.[22]

E. Development

The development cost for Jaguar was quoted as being $196 million in 1966. Initial plans, as of the fall of 1966, were for a production run of about 300 aircraft for the two countries collectively, while export potential was yet to be determined.

As of February 1967, the Jaguar was scheduled to make its first flight in 1968 with operational service to begin in 1970. At this time France was expected to purchase 150, and the UK 100 Jaguars.

The Society of British Aircraft Companies (SBAC), meeting in October 1966 criticized continuing British government delays in decision-making on a number of vital projects. As for the Jaguar project in particular, the absence of authoritative comment was said to be giving rise to wild speculation, reassurance being needed on the joint program's future.[23]

The Jaguar project becomes the first project to be endorsed 'NATO Project' in November, 1967, by NATO's Conference of National Armament Directors (CNAD)

[22]Marriott, op. cit., p. 79.
[23]Aviation Week & Space Technology, October 17, 1966, p. 29.

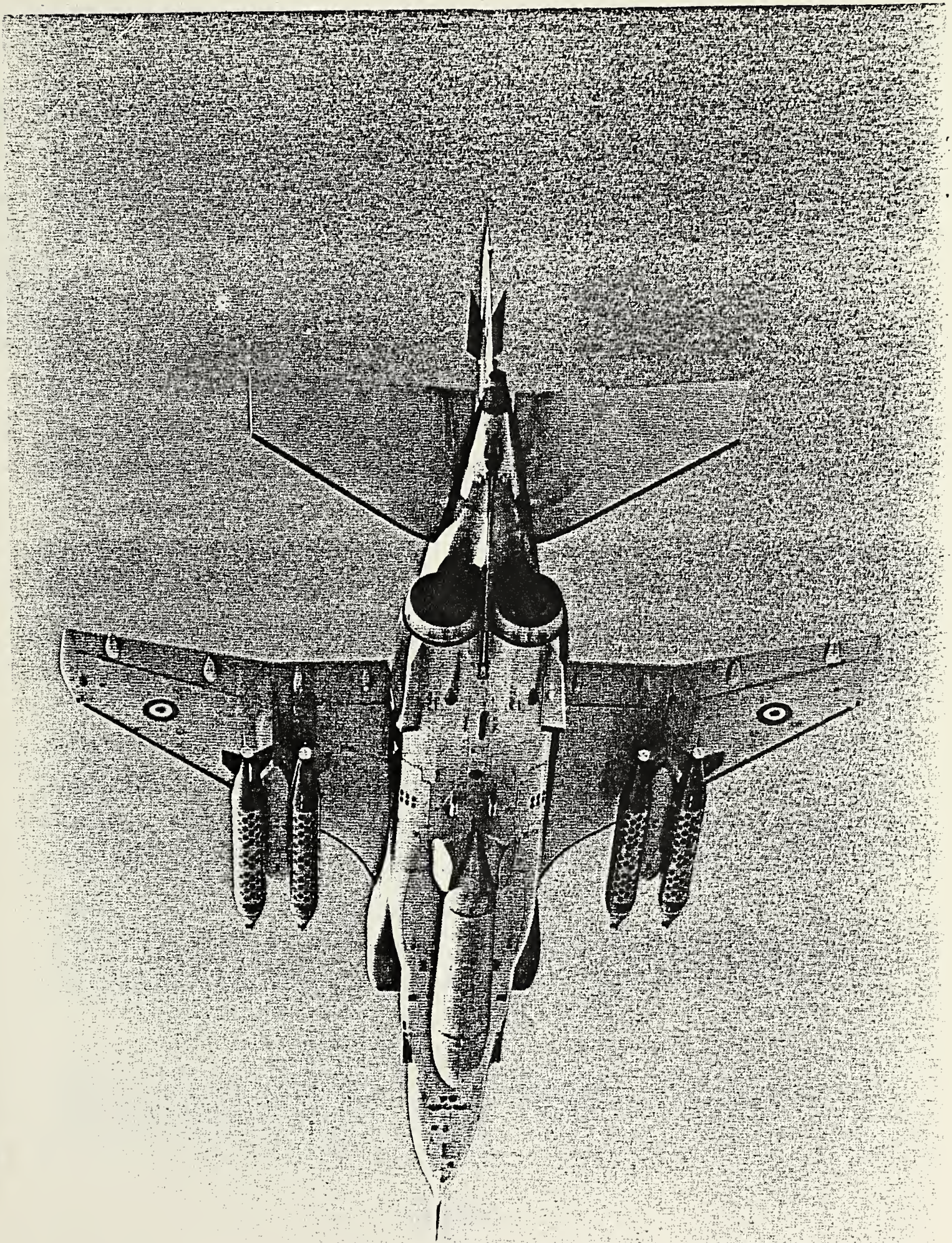
through the application of the new cooperative procedures set up by NATO and contained in the NATO Unclassified, Document C-M (66) 33, "Cooperation in Research, Development and Production of Military Equipment." This procedure replaced the previous NBMR (NATO Basic Military Requirements) procedures dating from 1959. (C-M(59) 82) The new cooperative procedure being applied by NATO was aimed at meeting with greater flexibility the principal NATO objectives in the research, development and production of military equipment.[24] May 1968 events in France followed by a prolonged strike delayed the program.

During 1969, following the first flight of the first prototype in September 1968, flight tests were progressing slowly due to problems created by the simultaneous development of airframe and engines. As a result of budget shortages early in the definition phase, it was decided that a flying test bed for the Adour engine would be eliminated so as to keep development costs low. Engines were therefore developed as far as possible in ground test cells and flight tested for the first time in the E-01 prototype (which crashed in early 1970). Since the Jaguar is a twin engine aircraft there is a safety factor in using untried engines on the Jaguar prototypes.[25]

Some problems were expected due to the parallel engine and airframe development but there turned out to be more than anticipated. This was mainly the result of the engines being constantly cycled in and out of the shops for modifications. Each time a new or modified engine is installed in a prototype, the first series of test flights are taken up verifying engine performance. Since the Adour

[24] Novel, op. cit., pp. 16-17.

[25] "Jaguar Production Starts with 80 ordered," Aviation Week & Space Technology, April 27, 1970, p. 111.



engines are government supplied items (UK), SEPECAT has no control over their availability. The governments did not plan on the high replacement rate encountered with the development engine or on the long factory turn-around time required for rework and modification. Program officials felt that in retrospect it probably would have been a good idea to have included parallel flight tests of the Adour in the program.[26]

The two governments encountered considerable difficulty in reaching an agreement on whether to use the metric or the Anglo-Saxon measurement scale on the aircraft. As such all drawings were made with measurements in both scales. Since a final decision had not been reached by the time prototype construction had started, BAC built its portion using the inch scale and Breguet followed the metric system in its respective areas of responsibility. Although the use of two different measurement scales on the prototype did not cause major problems, some interface problems were encountered between BAC and Breguet portions of the aircraft. These resulted in some delays in the building of the prototypes. Nevertheless, these problems were solved for the production phase, the Anglo-Saxon scale having been finally agreed to for the production models. Some French supplied equipment, however, which is not serviced in the field still may use the metric scale.[27]

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[26] Ibid.
[27] Ibid.

F. Production

The British and French Ministers of Defense signed a production agreement for 400 Jaguar aircraft, 200 each, on January 9, 1968. The agreement contained a penalty clause in the event that either government decides not to take its full quota of 200 aircraft. At this time production deliveries were expected to start in early 1970, building to full scale in 1971. SEPECAT (i.e., Breguet and BAC officials) predicted that building on their large order base the Jaguar will become a major export item, during the 1972 - 1982 period. SEPECAT is concentrating its export effort on those countries that need a low cost aircraft that can perform as many roles as possible.[28]

Because component contracts could be competitive across the wider industrial base offered by the combined industries of the two countries, one estimate figured that a savings of about 15% had been realized.*

The Jaguar program entered its production phase in April 1970 with the commitment of funds for an initial order of 80 aircraft from the two governments. First deliveries were to go to the Armee de l'Air in June 1971. Average flyaway cost of the Jaguar was quoted at $1.5 million and with total costs, including spares and support costs, amounting to a bit over $3.0 million. The cost of $1.5 million is based on a sales forecast by the SEPECAT team of a total of some 800 aircraft, including 332 exports of the tactical version and 71 for the trainer version.

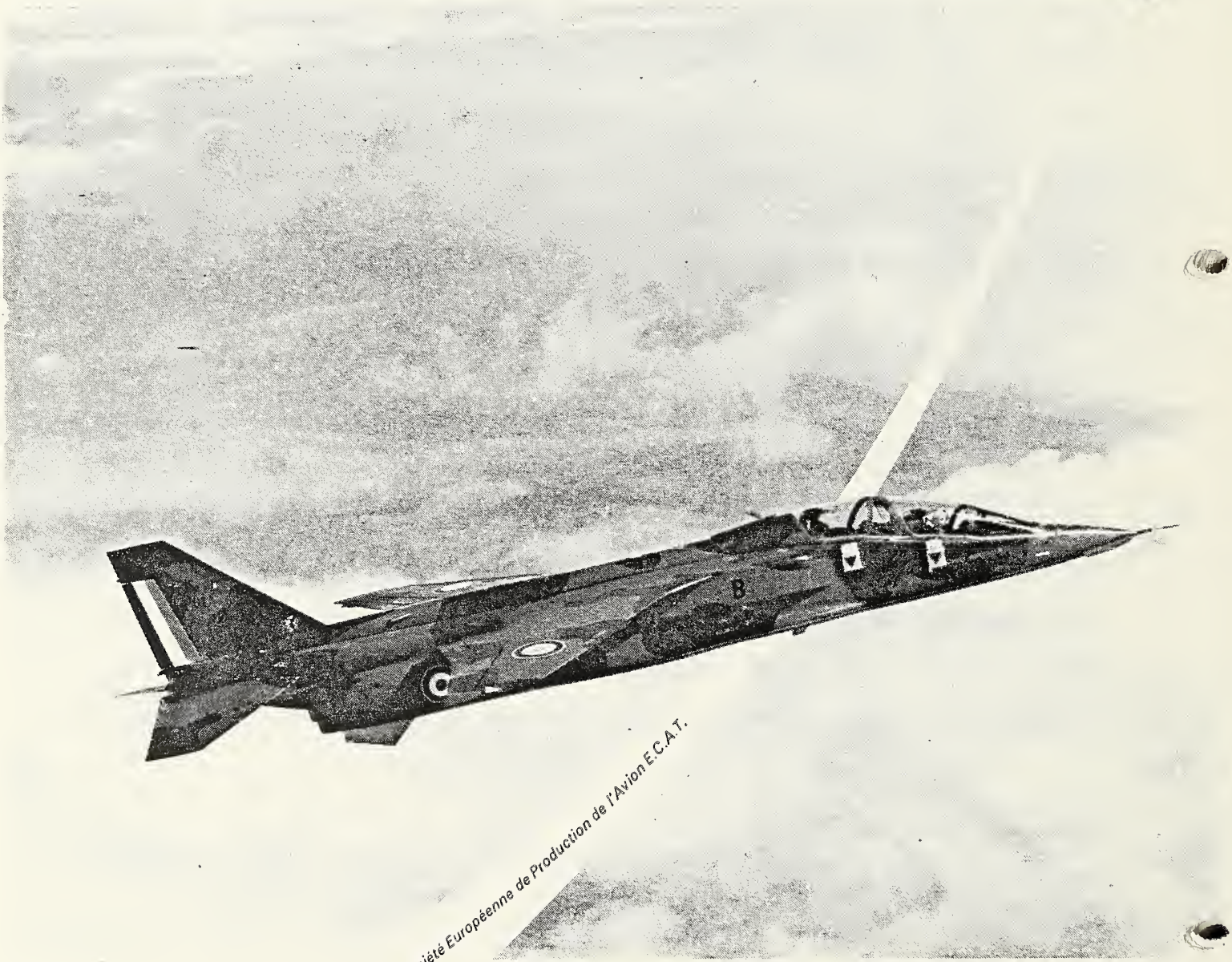
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[28]"U.K., France Sign Jaguar Production Pact," Aviation Week & Space Technology, January 15, 1968, p. 24.
*Kilcum, op. cit.

jaguar progress



While Jaguar flight development progresses – the second prototype flew supersonically on its very first flight in February – production lines for the 400 aircraft for the British and French Air Forces and French Navy have been laid down at the factories of British Aircraft Corporation's Preston Division and Breguet Aviation in Toulouse and Biarritz. Initial manufacture is divided equally between the single-seat tactical strike aircraft and the two-seat advanced trainer, following the eight prototypes built for development flying. Jaguar's smooth transition from prototype construction to full production status illustrates the suitability of this versatile Anglo-French military aircraft for licensed production in other countries.



Société Européenne de Production de l'Avion E.C.A.T.

S.E.P.E.C.A.T

British Aircraft Corporation
100 PALL MALL, LONDON, S.W.1.

Breguet Aviation
78-VELIZY-VILLACOUBLAY, FRANCE

The production rate was low to begin with, because prototype flight tests were still underway. This eliminated the time lags encountered in the traditional system of development prototypes, pre-series prototypes and finally the production aircraft. Therefore, during the initial period while the production rate was very low, modifications resulting from the final portion of the prototype flight test program could be incorporated in the production aircraft. The rate would then increase sharply when prototype testing was completed.[29]

This production plan was also more compatible with the needs of the two governments, as they must fund batches of aircraft progressively on an annual basis in accordance with budgetary limitations.[30]

Test engines gradually became available in greater supply during 1970, correcting a shortage that had occurred early in the year. The main problem involving the afterburner system, was overcome, and by late summer the first production engines were being built.[31]

In 1970, the British electronics industry asked the government to review its policies on demanding license agreements with European firms as part of collaboration in joint European projects. British industry leaders expressed fears that Britain was building up European avionics expertise that will redound in the form of new competitors in the future. As reported in the May 11, 1970 issue of Aviation Week & Space Technology,

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[29]"Jaguar Production Starts...," op. cit., P. 111-113.
[30]Ibid.
[31]Ibid.

In its presentation to the British government and Ministry of Technology, the Electronic Engineering Association pointed out that France has design leadership in the Jaguar strike fighter/trainer and the SA.330 and SA.340 helicopters. Germany controls design on the multi-role combat aircraft (MRCA), and Britian retains leadership only on the Westland WG.13 helicopter.

Abdication of leadership, the association continued, meant passing control of onboard and related electronics to other countries, and added: In the case of Jaguar, extreme pressure was placed upon (British) industry to negotiate manufacturing arrangements in France. Any British company attempting to negotiate such an agreement was placed in a position of negotiating from weakness, as it was a prior condition that equipment must be manufactured in France in order to have equipment specified on the aircraft.

The industry complained that the terms imposed on British firms were such that an "enormous amount of know-how and development experience was given to France, without any corresponding benefit to the British industry.

The government was reminded that prior to the Jaguar agreement, France was a large export market for British electronics, since the majority of avionics in the Dassault Mirage 3D and 3E, and Mirage 4 bomber was designed and supplied by British firms.

It is now likely, according to the association, that any competitive advantage gained through participation in the Dassault projects has been eroded by agreements which have since been forced upon the British industry in cooperative projects.

The industry also fears that in the MRCA program, it may be committed to supplying information and designs to the other participating countries - Germany and Italy - on commercially unsatisfactory terms.

The result of these agreements might be that British industry would be compelled by government actions to build up yet further competitors throughout Europe, the association continued.[32]

In 1972 a third major strike, this one at the BAC plant, caused a slippage of about three months in development work, although some production hardware work was shifted to France.

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[32] "U.K. Electronics Makers Ask Review of Cooperation Policy," Aviation Week & Space Technology, May 11, 1970, p. 59.

The RB.172/T.260 Adour engines afterburner problem, which had been a major problem for the Jaguar program was finally overcome, but was estimated to have added about $12 million to the cost of the program.

A flyaway unit price, having originally been based on a production of 800 planes, was now at $2.5 million plus an annual escalation of 8 percent.

The first Jaguar squadron in the Armee de l'Air was operational by mid 1973, and a second French squadron of Jaguars was operational early in 1974. By the fall of 1976 115 Jaguars had been delivered to the Armee de l'Air (the order having been reduced to 170 but later restored to 200) and 146 to the RAF. As of 1976, the Jaguar had become the British industry's biggest production program.

G. MARKETING

In October 1966, a SEPECAT sales team was trying to sell the Jaguar in Australia, New Zealand and Japan. Talks were also underway with the FRG. SEPECAT's total production forecast for the Jaguar was 1200 - 2000.[33]

Prospects that the FRG would join the Jaguar project were strengthened in March 1967, when a plan was announced for the FRG to buy $500 milion in U.S. bonds in order to offset the costs of keeping U.S. troops in the FRG. The move freed the FRG from its commitment to purchase U.S. military equipment and thus permitted an expanded German participation in European military joint development and production programs. The FRG was exploring the possibility of entering the Jaguar

[33] Aviation Week & Space Technology, February 13, 1967.

production program as a replacement for its Fiat G-91 close support aircraft*. During the summer, the FRG was told that it had until October to decide on participation or not, since the Jaguar program could not cope with drawn out negotiations.[34] In the end, the FRG opted out of the program.

France pulled out of the parallel AFVG fighter program in mid-1967, but with no disruption to the Jaguar half of the fighter package. The first flight of a Jaguar prototype was expected for March 1968 as of this time. However, with the collapse of the AFVG fighter project and the similar fate awaiting the U.S./German AVS fighter project in January 1968, the FRG and the UK (again BAC) were able to get together on another fighter the following year, the Tornado. Two years later in 1970 with launching of the Alpha Jet project the Germans joined up with French (again Dassault-Breguet) to obtain a G-91 replacement.

The salability of the Jaguar in the export market is beginning to be disputed by some observers, particularly in France. Even though the 1964 specifications for the aircraft contained a clause that it be inexpensive, certain estimates as of the summer of 1968 indicated a unit cost in excess of $3 million. At this time program officials were declining to discuss unit costs.**

In 1970, SEPECAT presented the Jaguar to a number of countries including Switzerland, Australia and the United States. North American Rockwell Corp. had shown some interest in licensed production, having at one time considered trying

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[34]"German Jaguar Participation Expected," Aviation Week & Space Technology, March 20, 1967, p. 22.
*Donald E. Fink, "Politics Alter German Air Force Plans," Aviation Week & Space Technology, April 3, 1967, p. 35.
**Koleum, op. cit.

to interest the U.S. Navy in it and the low R&D costs involved. A derivation of the Jaguar was specially prepared for the USN while another had been previously adapted for the U.S.A.F. as a T-38 replacement.[35]

The British government, apparently with the French government's approval, embargoed the sale of the Jaguar to the Egyptian Air Force, in November, in spite of an urgent request from Cairo for the aircraft.[36]

In 1973, a low-key effort to set up a BAC/Hawker Siddeley Aviation consortium in order to sell the Jaguar and the HS.1182 Hawk jet trainer as a package collapsed, when the Belgians selected the Dassault-Breguet/Dornier Alpha Jet.[37]

Later in the year though, British industry again teamed up in a major effort to sell the Jaguar to Belgium as an F-104G replacement, but this time in competition with the Dassault Mirage F-1. Although ostensibly the Belgians were still interested in the Saab Viggen and the Northrop Cobra, it appeared at that time that the contest would be primarily between the Jaguar and the Mirage F-1. Consequently, for the second time in one year BAC found itself competing against its French partner.[38] In what appeared to be a unilateral move, a British industrial team consisting of BAC, Rolls-Royce, GEC-Marioni Elliott, Smiths Industries, and Plessey presented the Belgian government with an industrial package deal that would give a large portion of assembly work to the Belgian firms SABCA, Fairey and several avionics companies. A complete license was also

[35]"Anglo-French Jaguar Enters Production Cycle," Aviation Week & Space Technology, September 7, 1970, p. 54.

[36] Aviation Week & Space Technology, November 20, 1970, p. 24.

[37]"British Push Jaguar in Belgium," Aviation Week & Space Technology, December 10, 1973, p. 23.

[38]Ibid.

a possibility. Dassault was also offering a work sharing plan. The initial Belgian order was to have been for 50 aircraft.[39]

Neither the British nor the French governments took any overt actions to support or block the British industrial move. The British deal was made with the knowledge of SEPECAT, but Dassault-Breguet had now assumed a lesser role in sales promotion. In any case, Dassault-Breguet would still have had a share in any Belgian order for the Jaguar under the joint agreement.[40] The situation was drastically reversed however, early in the following year when Belgium opted to form a purchasing consortium for the F-104G replacement with the Netherlands, Norway and Denmark which among other things eliminated the Jaguar as a serious contender.

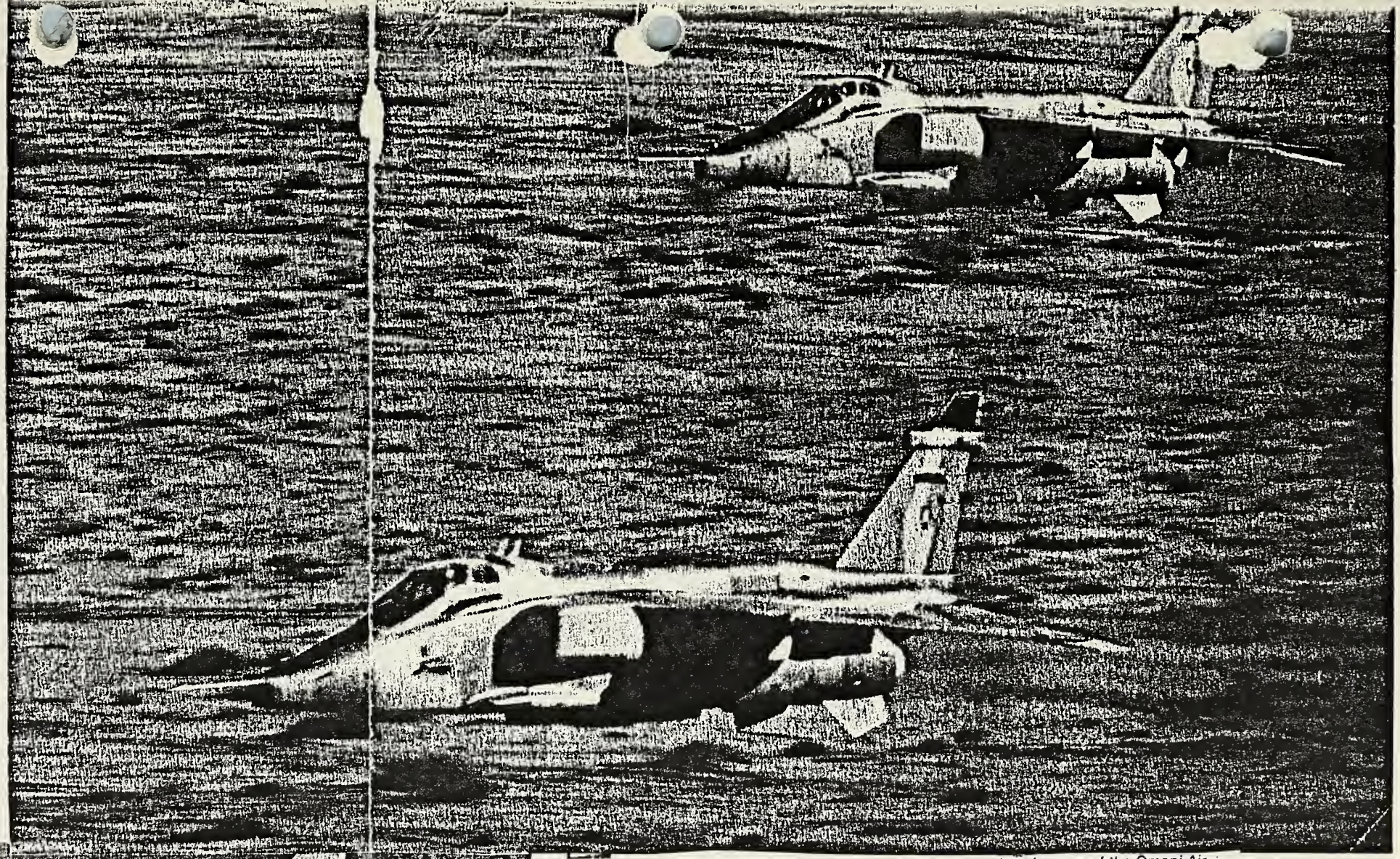
This dilemna of BAC found itself in that of competing with its partner, stemmed from a French government policy of the late 60's. As part of an effort to consolidate French industry and improve its international competitiveness the French government asked Dassault and Breguet back in January 1967 to explore the possibility of closer cooperation, and possibly even merger. In May 1967, Dassault and Breguet announced their planned partial merger with Dassault purchasing a 66 percent of Breguet's stock. The two firms have been brought together under a single top management team, while they will each continue to function independently at the operating level for several more years.[41] Dassault and Breguet finally consumated a 100% merger in October, 1971.

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[39] Ibid.

[40] Ibid.

[41] "Europe Challenger U.S. for World Market," Aviation Week & Space Technology, Mary 18, 1968, p. 91.



two Jaguars of the Omani Air Force carry out a low-level pass during a training exercise over the desert. (Photos courtesy British Aerospace)

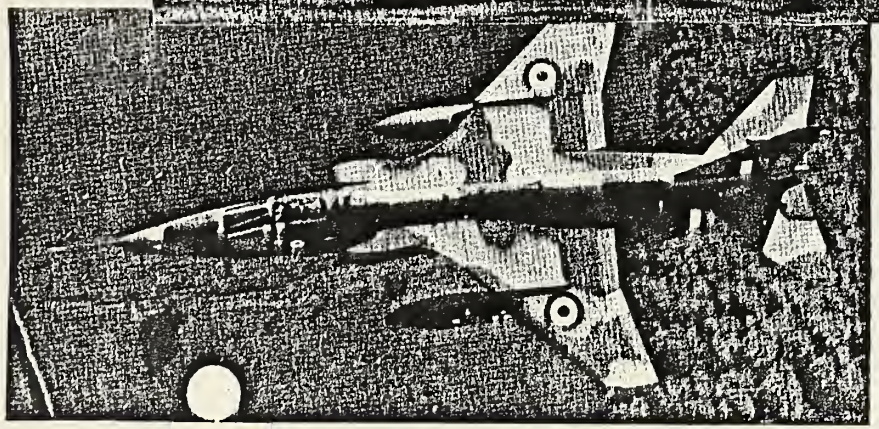


photo shows details of an Indian Air Force Jaguar of its initial batch of forty

During the five years following the Belgian competition the only third country orders for the Jaguar were for a total of 24 aircraft from Oman (12) and Ecuador (12).

In early fall 1978 the Jaguar's first major export break came when the Indian government decided in principal to buy 200 Jaguar aircraft over the Dassault-Breguet Mirage and the Saab Viggen to replace its fleet of BAC Canberras, and the Hawker-Siddeley Hunters. 40 of the aircraft are to be assembled in the UK (but manufactured by the SEPECAT partners in both the UK and France) and the rest are to be built in India by Hindustan Aeronautics, Ltd. Serious negotiations between BAC and the Indian Air Force had begun in 1973, with it having been hot or cold ever since, largely over the question of financing. The agreement was signed by British Aerospace (the result of the 1977 merger of BAC and Hawker Siddeley) and not by SEPECAT, since the Indian government had chosen the version with British avionics.[41]

[41] "India selects Jaguar International," Aviation Week & Space Technology, October 16, 1978, p. 26.

H. Conclusions

As in all of the European codevelopment and coproduction programs the Jaguar program has its quota of pluses and minuses. On the negative side there are the usual increased time and cost problems, the greater vulnerability due to its exposure to two national political/economic environments, and the basic conflicts of national interests that inevitably crop up in such transnational ventures. The specific manifestations of these in the Jaguar program with regards to cost involved on overall program price of about 40 - 50% higher than a one nation effort. For the increased time involved in coordinating such a venture, there are such problems as the several months of disruptions caused by each of the strikes France (1968) and the UK (1972). These strikes are also examples of the increased vulnerability of such programs to destablizing events occurring in either nation. The difficulty in reaching a mutually acceptable compromise with the issue of the metric versus the Anglo-Saxon measurement systems was yet another example of the conflicts that can crop up.

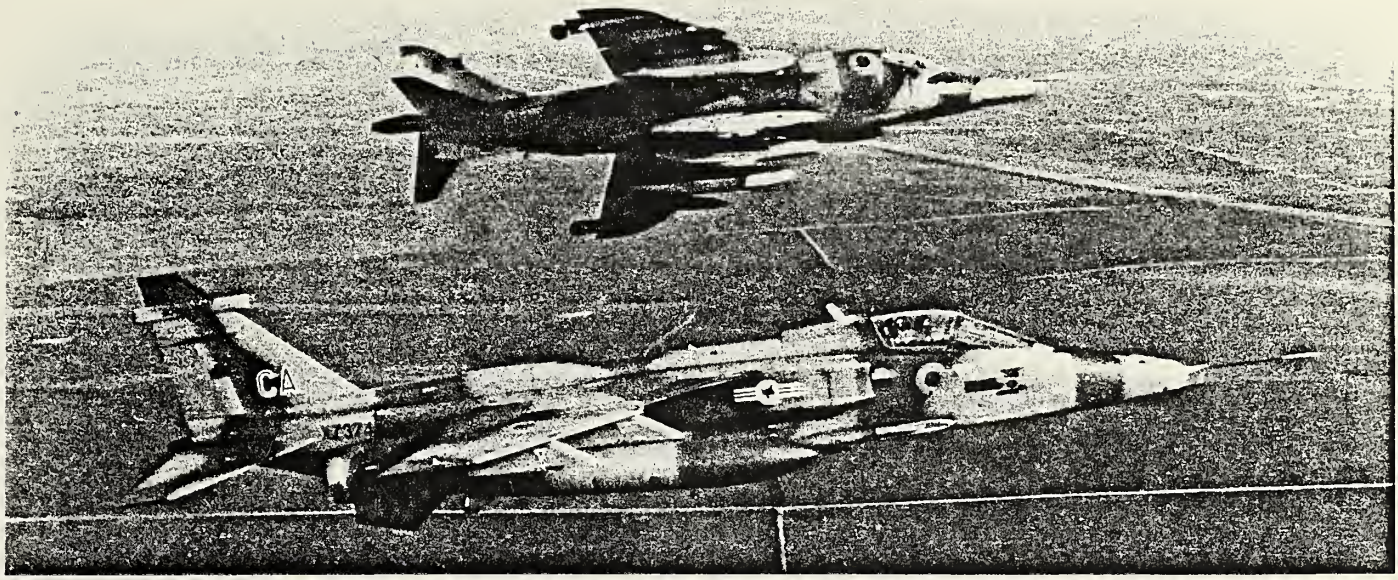
An example of national economic policies impinging upon the interests of such a venture and which has also probably been the most serious difficulty faced by the Jaguar project, is that of the merger of Dassault and Breguet, partially in 1967 and totally in 1971, once the program was under way. This merger was part of process strongly promoted by the French government of consolidating industrial sectors along national lines so as to strengthen French industry for competiting in the world market place. Valid as this policy was, nationally, it had, however, a negative effect on the export potential of the Jaguar and thus conter-acted the supportive effect of the French half of the 400 plane order base. As for Dassault it is unlikely that it would ever have taken part in such a project,

since it was seen by the Dassault sales office to conflict with the market for the Mirage, and later the Alphajet as well. Dassault is also among those French critics that dispute the general salability of the Jaguar on the basis of its cost.

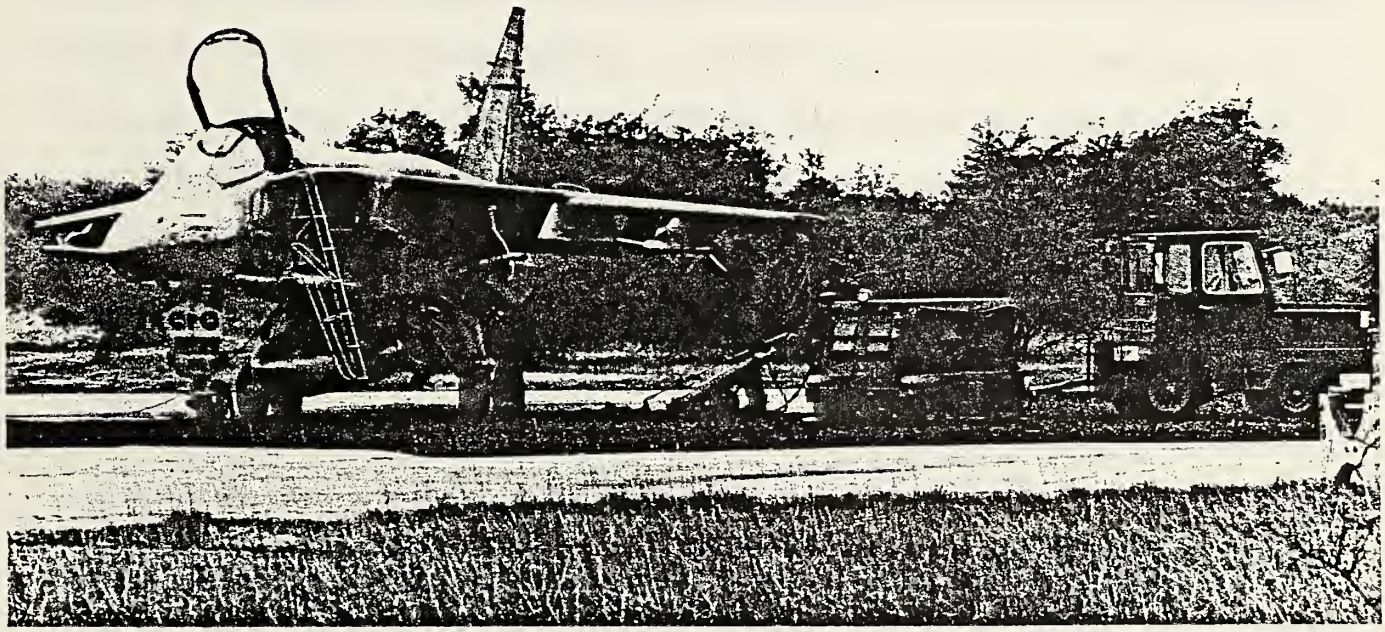
Then there is the criticism of all such projects with regards to the inevitable inefficiencies that result when attempting to satisfy the principles of 'juste retour' within one project. In structuring the transnational venture, efficiency would suggest that British industry having Europe's dominant avionics and jet engine industry develop and produce the engine and avionics. But if this course was followed the heart of the project, the airframe would go principally to French industry with Britian's airframe firms losing out.

The airframe part of a project is of major importance not only in sustaining and developing this key national industry but also vis-a-vis the national prestige associated with the project. In order to avoid such a contingency and still satisfy all the national constituencies engine and airframe development and production are each split up 50 - 50, along lines paralleling the sharing of costs. This in turn has meant a flow of technology from the British engine firms and avionics firms to their French competitors.

All this considered, there is also the positive side of the program. As always with these joint development and production programs there are the usual advantages of considerable import: industrial, technological, BOP, independence, prestige, and the experience gained. There are also several other particular advantages occuring to the programs credit. First, because component contracts were competitive, principally between British and French companies

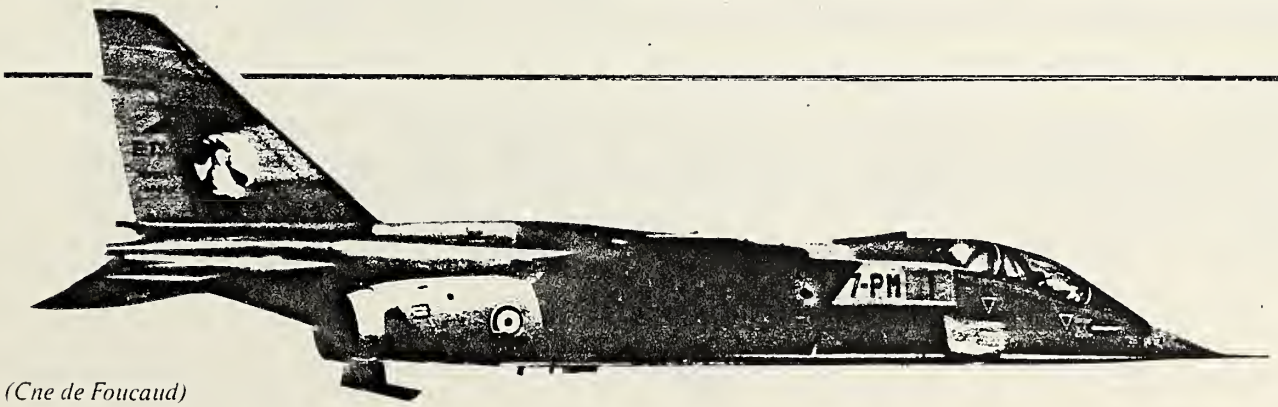


An RAF HARRIER and JAGUAR. Both these types of aircraft will need to be replaced in the 1990s.



(Adc JP Dixmier)

N° 358 - Air Actu Février 83



(Cne de Foucaud)

(within the 50 - 50 work sharing constraint) it was estimated that savings of around 15% were realized. Second, BAC's contribution to the program of a greater experience in reasonably high rates of mass production was complimented by the greater experience of Breguet in transnational ventures (resulting from the Atlantic program). Third, export prospects are improved because of the two privileged spheres of influence as well as from the proposed number of versions (though significantly counteracted by cost and the Dassault-Breguet merger). Fourth, although the program cost some 40 - 50% more than a one nation effort, the saving to each nation individually from establishing a joint program was some 25 - 30%. Fifth, in spite of the limited export results of the Jaguar itself, the Adour engine developed in parallel for the Jaguar has found a wider market, also powering the Mitsubishi T-2 trainer and the Hawker Siddeley Hawk trainer. Sixth, again in spite of the export problems, the substantial order base of 400 aircraft (itself an increase over the original combined estimate of a need for 250 - 300 aircraft) was maintained. Finally, one last point emphasized throughout the literature was the excellence of the cooperation between the national teams of engineers and mechanics. The language problem was overcome by crash courses in the opposite language held on both sides of the channel and the minimal flight time of 45 - 90 minutes between the two nations plants allowed for frequent meetings on very short notice. In the words of Mr. Vallieres, the Managing Director of Breguet: "the friendship between our two teams has been one of the essential elements in our success; with a staff that could not have got on together, the business would have been seriously handicapped. We have learned to know one another and, each depending on the other, we have worked ... in a most brotherly way. This is very important."[14]

[14] Nouel, Elise, NATO Letter, July/August, 1978, p.17.

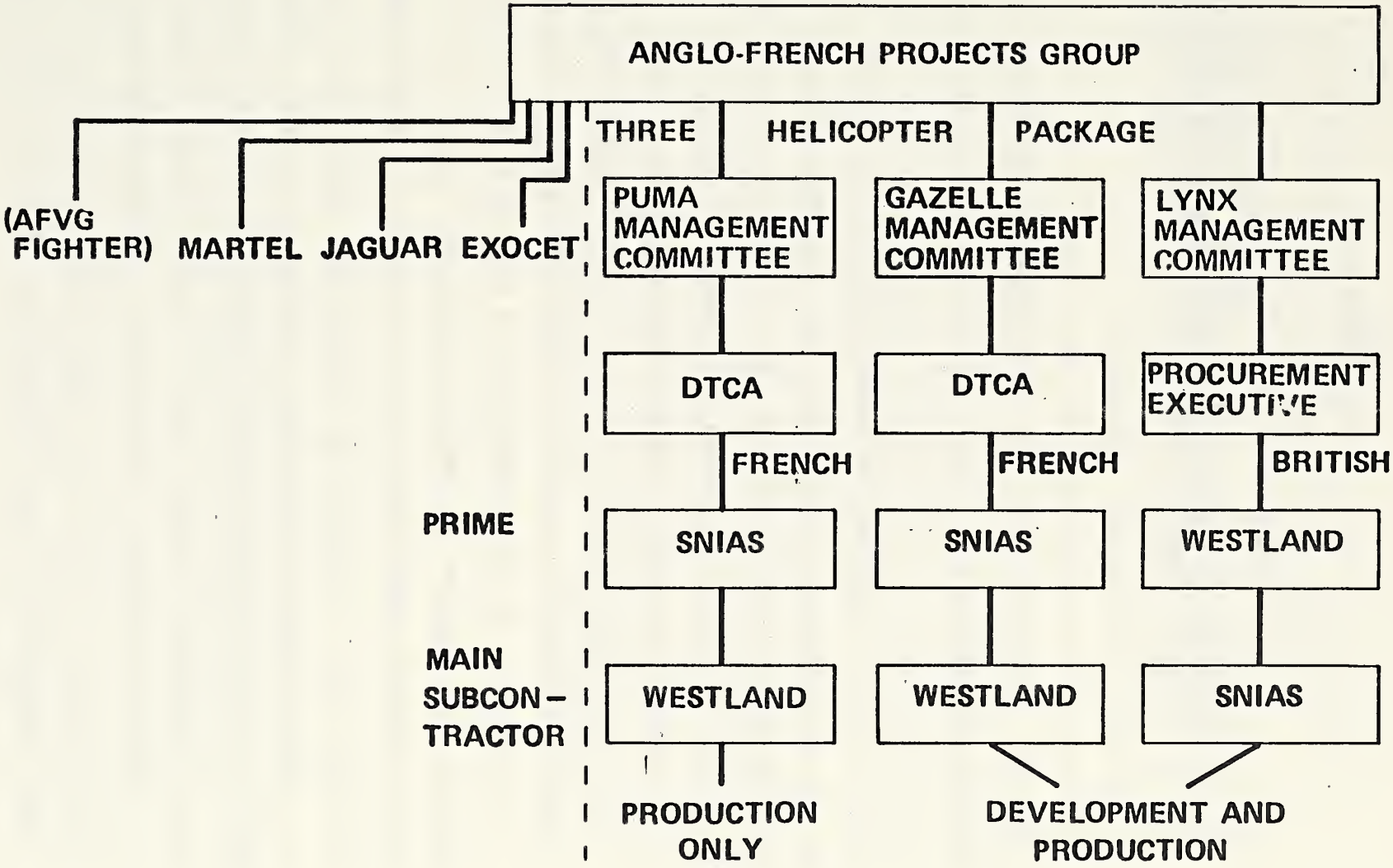
B. THE PUMA-GAZELLE-LYNX HELICOPTER DEVELOPMENT AND PRODUCTION PACKAGE

In early 1967, after around a year of gestation, France and the United Kingdom signed an MOU covering the joint development and/or production of three helicopters, the SNI Aerospatiale (SNIAS) Puma and Gazelle, and the Westland Lynx. Cooperation had begun in early 1966 between Sud-Aviation, now SNIAS, and Westland, followed by similar arrangements between Turbomeca and Rolls Royce for the power plants. After a broad analysis of British and French helicopter requirements the Anglo-French Projects Group had decided that it was possible to reach a common technical definition for the basic helicopters, with each country then fitting the helicopters with special equipment to meet their own particular needs. The United Kingdom had only a limited requirement for a Puma-class transport helicopter (already developed in France) while the same was the case for France with a Lynx general purpose and naval helicopter (yet to be developed). In each case where the requirement was limited development and production cost would have been excessive in proportion to the guaranteed domestic order base. For the Gazelle light helicopter (yet to be developed) both partners required similar numbers. In all three cases the larger order base was expected to facilitate access to the international market.[42]

The principle adopted for the organization was to maintain responsibility under a sole authority at both the government agency and contractor levels. Contracts

[42] Henri A. Ziegler, International Cooperation in Aerospace Projects: Cooperation Between European Industries and Between Europe and the United States, text of a paper presented to and published by the American Institute of Aeronautics and Astronautics, in 1975.

Three Anglo-French Helicopter Projects



are placed on behalf of both countries by the executive agency of the prime contractors national government, the financial aspects then being settled between the governmental authorities. Each prime contractor is technically, industrially and commercially fully responsible for its product. However, for export sales, the two firms' sales teams work in coordinated effort. Work sharing is distributed between the prime and subcontractor of the respective projets approximately in proportion to national orders. In the integrated prime/subcontractor relationship there is no duplication of parts manufacture, but the national firms do outfit the special versions for their respective nations.

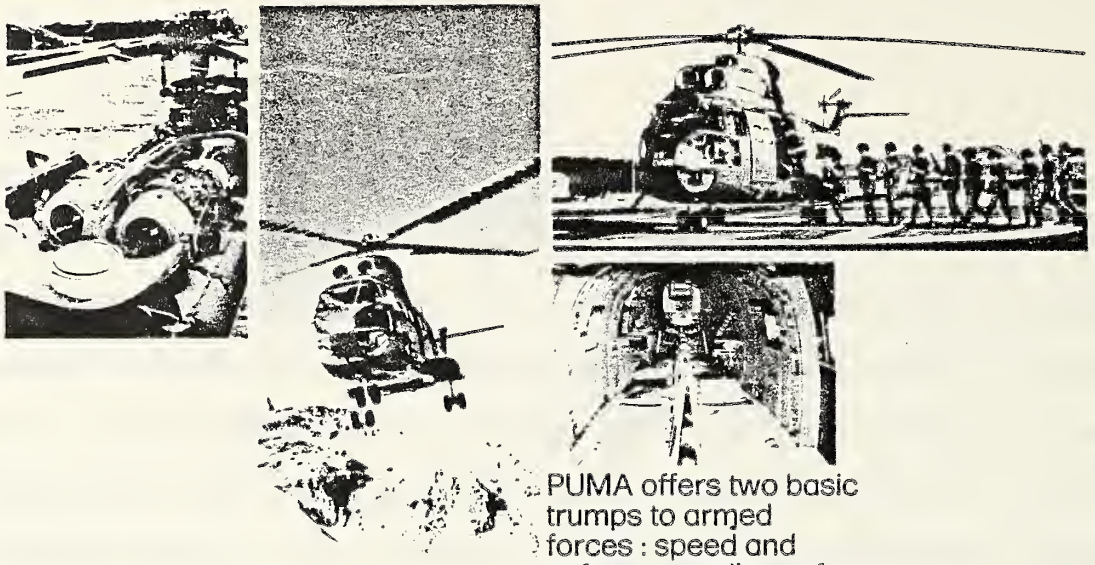
As in the case of the Jaguar, the whole helicopter project is overseen by the Anglo-French Projects Group at the intergovernmental level. Westland and SNIAS each have permanent representatives stationed with each other, both on the engineering and the sales side. The Rolls Royce and Turbomeca partnership goes back a long way and their interchange of engineering personnel extends down to apprentice level.[43]

Collaboration amongst the working staffs has reportedly gone very well. Although the French are better at learning English than the English are at learning French (as might be expected for Anglo-Saxons), there has really been no language problem. The somewhat higher costs involved than for a purely national project have been reducing as experience is gained.[44]

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[43] Ibid.

[44] Marriott, op. cit., p. 78.



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To further consolidate and extend their collaboration Westland and SNIAS formed a joint company, Heli-Europe in September 1974. Heli-Europe has taken over the management responsibility of the current Puma, Gaxelle, and Lynx programs and has been exploring further collaborative efforts both between these two firms as well as in associating the other European helicopter firms.[45]

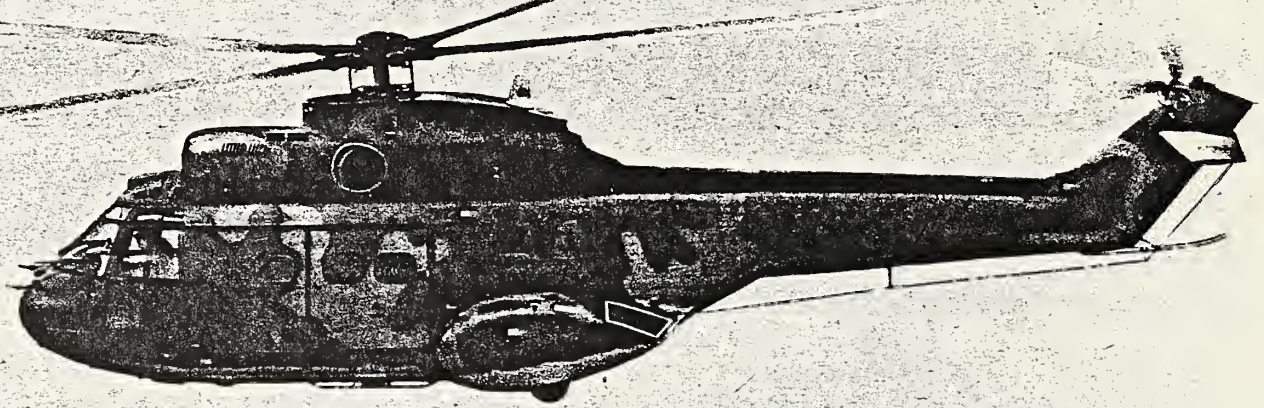
1. SA.330 Puma

SNIAS had already commenced with the production of the SA.330 Puma when the MOU was signed in early 1967, its first flight having been in April 1965. Thus apart from a small development contract from British government for the installation of certain equipment to British mission requirements, the Puma was unilaterally developed by SNIAS. As for production, Westland produces, as principal subcontractor to SNIAS, part of the fuselage and engine cowlings, tail rotor blades and various other items and Rolls Royce produced part of the engines. In all some 27% of the production is British.[46]

An additional point that is worth mentioning, as it is representative of the extensive ties that Sikorsky has established in Europe generally, the Puma's blades are based on technology obtained in a cooperative program involving SNIAS and the U.S. firm.

[45] Ibid.
[46] Ibid.

PUMA sa330L



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The Puma was designed to meet a 1963 French Army requirement for a highly maneuverable tactical helicopter capable of high speeds for troop transport, light cargo transport, and logistic support. The troop carrier version can seat 16 troops and the cargo carrier version has 353 cu. ft. available. The Puma is powered by two Rolls Royce/Turbomeca 3C4 turboshaft engines.[47]

The original order base provided for the Puma by the two governments included 48 for the RAF and 130 for the French Army, but both dropped somewhat - the British order to 40 and the French order to 115. As of spring 1977 some 525 Pumas had been sold, 2/3 of which were for export. From the beginning the Puma has had a remarkable sales history, with some 163 having already been sold to six customers before the first production model had even been built.[48]

Apart from the continual improvements to the basic design, a new development, the Super Puma, has been underway. Since the French military has no requirement for such an aircraft it will be oriented towards the civil and export markets.

2. SA.341 Gazelle

The SA.341 Gazelle was a joint development project from the start with SNIAS as the lead contractor. The design was based on the very successful Alouette II. Being still in the early design state when the protocol was signed in early 1967, both British and French requirements are reflected in the design. Although

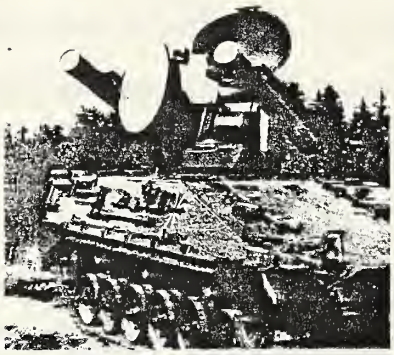
[47] Ibid.

[48] Edward H. Kolcum, "Sad Broadens Helicopter Marketing Base," Aviation Week & Space Technology, February 2, 1970, p. 52.

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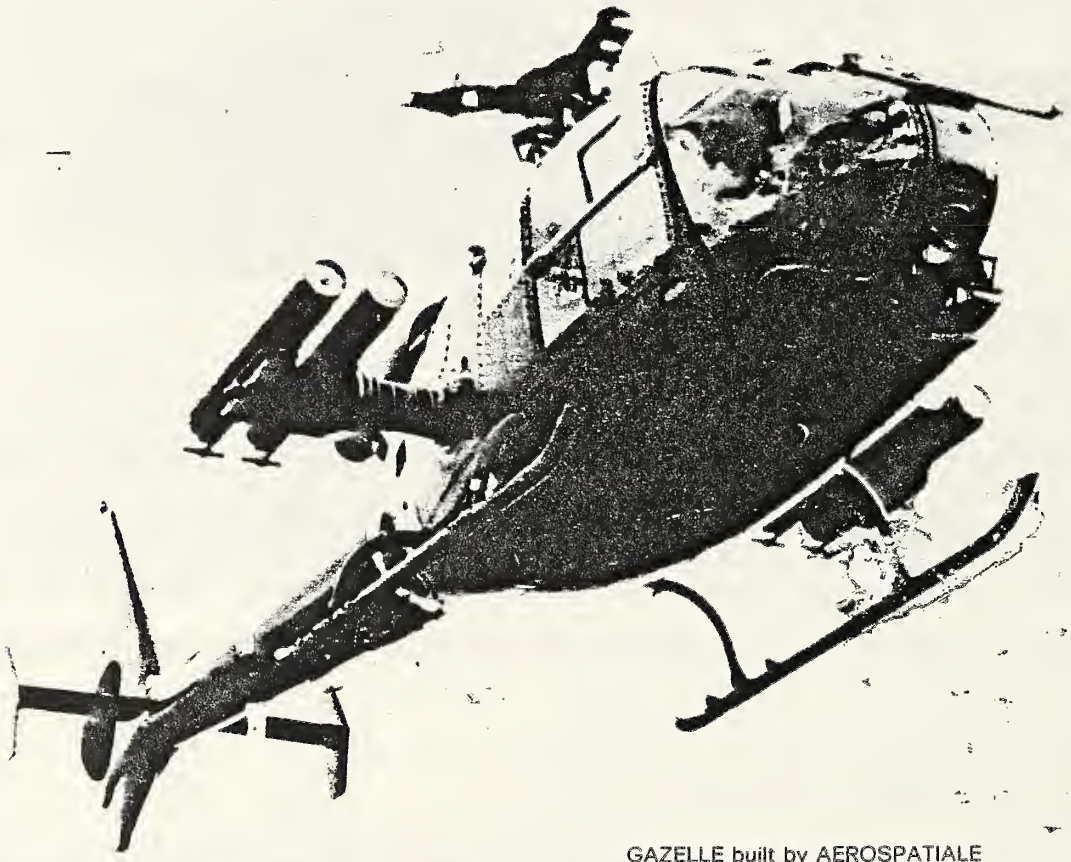
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GAZELLE built by AEROSPATIALE in cooperation with WESTLAND HELICOPTERS

Westland was only a minority development partner for the Gazelle, Westland produces approximately 65 percent of the aircraft. The remaining 35 percent is produced by SNIAS.[49] This distribution is in part due to the original British army order being for 250, while French army order was for some 170.[50] The first deliveries were in 1972, and as of Fall 1976 the French army was still to get 170 Gazelles, with the British order being down to 214.[51]

France had been responsible for a delay in 1969 in obtaining approval for full production pending final analysis of the effect of the devaluation of that year on the total French defense procurement picture, but unlike with the WB.13 Lynx, no cut in the French army order resulted.[52]

The Gazelle's engine is a Turbomeca Astazou IIIB built in cooperation with Rolls Royce.

The Gazelle is designed as a light, multi-purpose machine and it can carry up to three passengers plus a pilot and co-pilot. It can carry anti-tank missiles and can be used in a large number of roles including reconnaissance, artillery observation, transport and casualty evacuation.[53]

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[49]Marriott, op. cit.

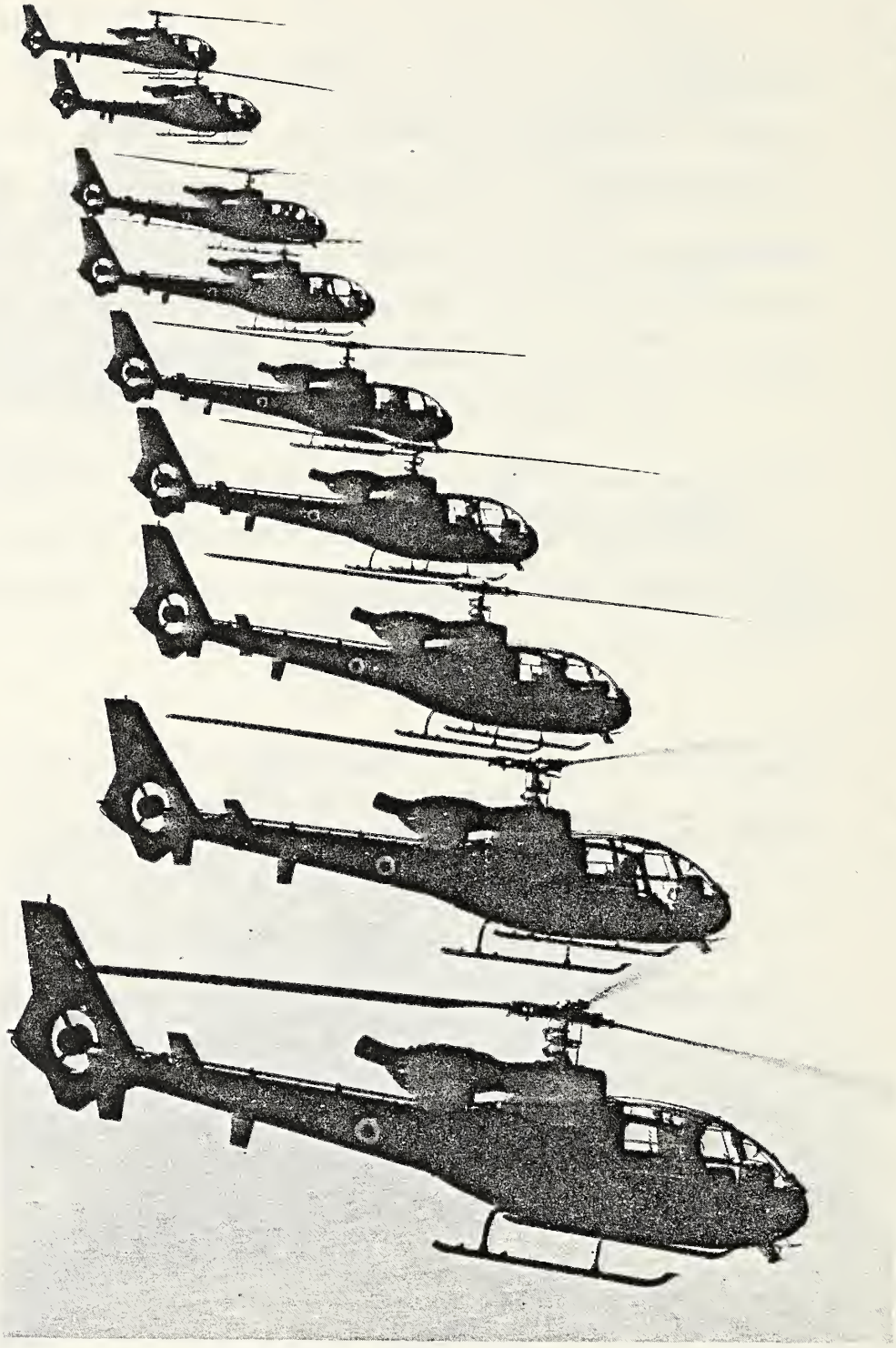
[50]"New Orders Bolster Helicopter Program," Aviation Week & Space Technology, September 7, 1970.

[51]Marriott, op. cit.

[52]"French Cancel Helicopter Order," Aviation Week & Space Technology, November 3, 1969, p. 18.

[53]Marriott, op. cit.

Royal Navy Gazelles in formation.
Photo: Fleet Chief Petty Officer Charles Robinson, R.N.A.S. Culdrose



Over 700 of the Gazelle had been sold by spring 1977. It is also being manufactured under license in Yugoslavia.[54]

According to SNIAS marketing officials the combined export sales effort has some built in advantages. For example vis-a-vis negotiations in 1970 for sales of the Gazelle, France has traditional and linquistic this with Romania, French speaking sales teams being especially effective there. France and Romania also had a trade and technology agreement signed in mid-1970, which also helped. Whereas in negotiations in the same year with Australia, a Westland sales team carried the main burden in negotiations for similar reasons.[55]

3. WG.13 Lynx

In the case of the third Anglo-French cooperative helicopter project, the WG.13 Lynx, Westland is the prime contractor. SNIAS is the minority development partner and as subcontractor has some 34% of the production. The Lynx was also designed to meet the requirements of the British and French Armed forces.[56]

There are two versions the general purpose machine and the Naval Lynx. The general purpose version can be used for troop transport-seating up to 10 fully equipped soldiers as well as an ambulance and freight carrier. The naval version is primarily used for anti-submarine and surface strikes.[57]

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[54] "The French aerospace industry - on course for the 1980's?," Interavia, 5/1977, p. 419.
[55] "New Orders...," op. cit.
[56] Marriott, op. cit.
[57] Ibid.



Britain is to arm some 100 Lynx helicopters with the Hughes Aircraft Co.s TOW missile. TOW launchers on a Westland-Aerospatiale Lynx helicopter.

Source: NATO's Fifteen Nations

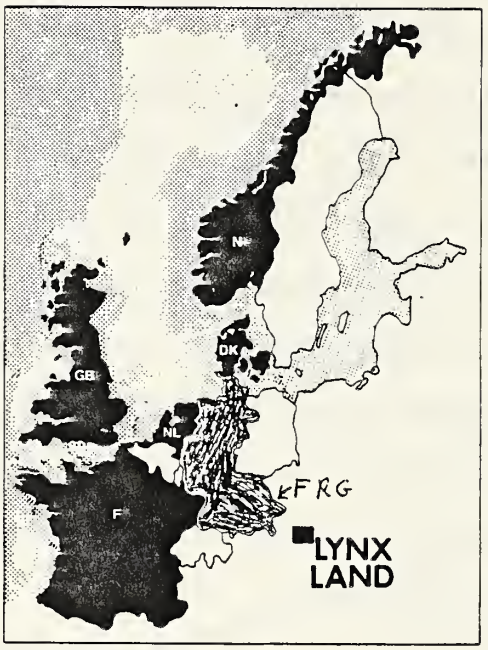
The combined Anglo-French order base for the Lynx went through a tumultuous period during 1969 and 1970. The original plan had been to build about 520 Lynxes in five versions for the two nations armed forces plus a civil version. In October 1969 however, citing post-devaluation financial reasons, the French government cancelled its order for about 150 Lynx aircraft for the French Army. At this time however, the French Navy was still planning on taking its original number of about 80. Concurrently the British army which was to take the rest of the Gazelles, was reportedly quietly investigating the Bell Jet Ranger as an alternative off-the-shelf buy or with partial construction by Westland.[58] However, a month later both governments approved full production of the Gazelle and development of the Lynx.

Then, once again, in the Spring of 1970, French officials raised the possibility that they might not be able to order 80 of the Lynx helicopters for the French navy, because of budget restrictions and the large investment required for the French nuclear submarine fleet. The whole Anglo-French helicopter program then came under review, as it seemed that it might be going the way of the joint Jaguar and variable sweep fighter development package before it (i.e., the British traded off design lead for the Jaguar against design lead for the variable sweep fighter, but then the French pulled out of the latter of which the Jaguar was the surviving half). However, the helicopter package did hold together, and the new French commitment to order 40 Lynx has been maintained.[59]

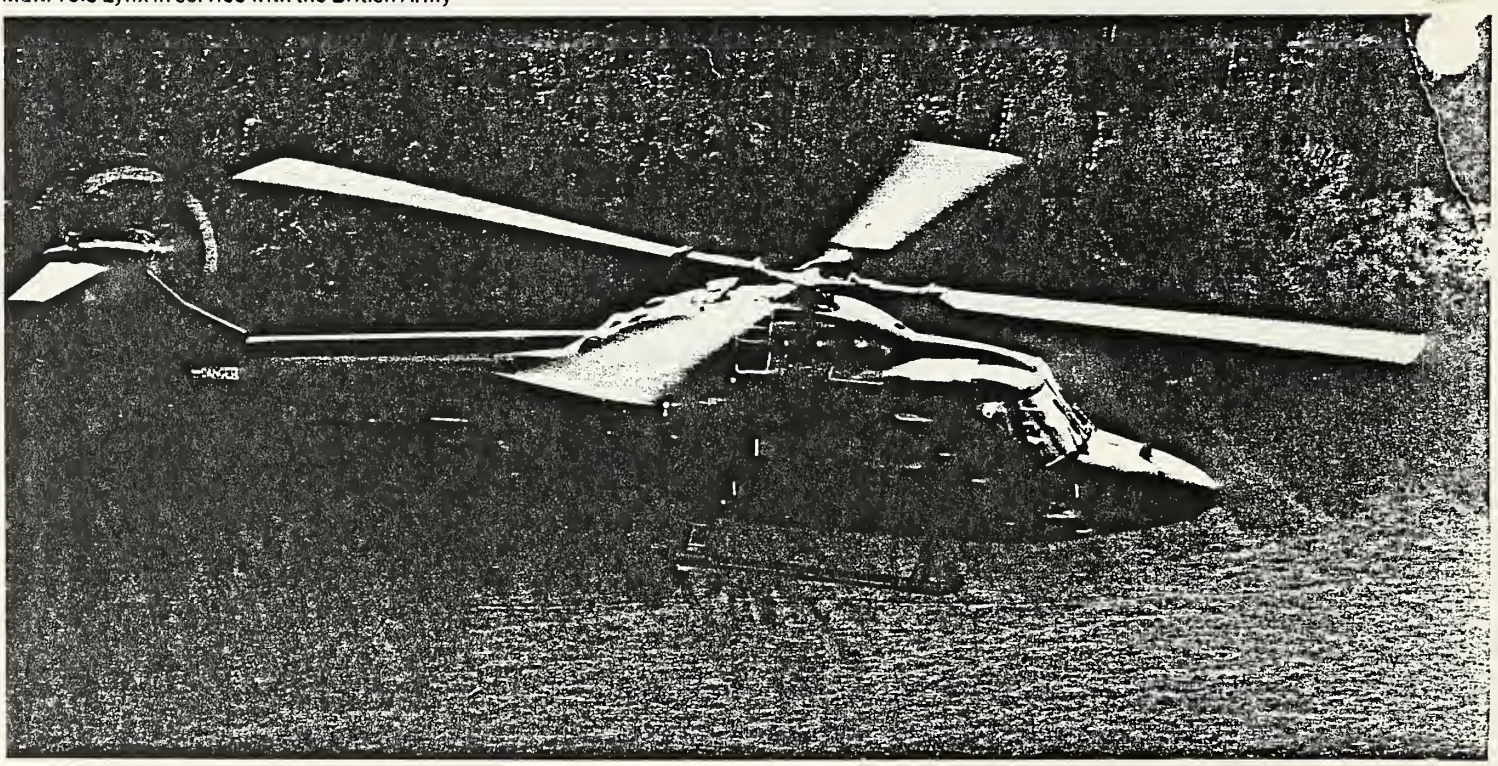
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[58] "French Cancel...," op. cit.

[59] "Budget Squeeze in France Spurs Taks with British on Helicopters," Aviation Week & Space Technology, April 13, 1970, p. 21.



Multi-role Lynx in service with the British Army



Also in 1970, the Lynx was being considered by the USN for its light airborne multi-purpose system (LAMPS), with United Aircraft Corp.'s Sikorsky division as potential licensee. Other U.S. manufacturer's were reportedly interested, but in view of Westland's long relationship with Sikorsky, Sikrosky was to be given first refusal.[60]

As of late 1976 firm orders by the British armed forces stood at 93, and by early 1978 total orders for the Lynx were 231, being in service currently with the British army and the navies of France, the U.K., Netherlands, Denmark, Brazil, and Argentina.[61] Norway and the FRG have since placed orders as well, which means that as of 1980, six NATO European nations were using this one helicopter.

Contributing to a several year delay in the development of the Lynx has been the difficulties with the Rolls Royce B5-360 engine, which was being specially developed for the project.

In addition to the previous total of 231 orders, in March 1978, the four Arab nations participating in the Arab Organization for Industrialization (AOI i.e., Egypt, Saudi Arabia, Quatar, and the United Arab Emirates) ordered the first batch of 50 Lynx helicopters of an anticipated order of 250. Westland and AOI had formed a joint company, called the Arab British Helicopter Co., to manufacture the Lynxes in Egypt. The first batch of 50 were to be split, with the first

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[60] "New Orders...," op. cit.

[61] "Rolls Royce in $200 Million Middle East Helicopter Engine Deal," Aerospace Daily, March 3, 1978, p. 20.

20 helicopters being manufactured by Westland/SNIAS, the remaining 30 to be assembled in Egypt. Subsequent batches of 50 were to built increasingly in Egypt, with about 80% of the final group manufactured there. The total production run for the 250 helicopters envisioned at that time, was expected to last about seven years.[62] As with the similar arrangement for the Alphajet's joint production with the AOI, these have been suspended in line with Saudi-Egyptian split following the latter's peace agreement with Israel.

4. The 3 Projects and the Progress of the European Helicopter Industry

The three helicopter program was an important part of a process, by which European helicopter industries have increased their independence and competitiveness vis-a-vis the American industry (if not with regards to each other). This bi-national program facilitated the two firms overcoming of the initial hurdles of financing and risk that would ordinarily have been faced in focusing their initial effort toward the limited national market provided by their respective armed forces.

In the period following WWII extensive industrial relations were developed between U.S. and Western European helicopter firms. As of the early 1950's the U.S. designed and built some 72% of the helicopter inventory of the non-communist world and a further 12.5% were U.S. products built under license in Europe. Western European production of helicopters of their own design accounted for the remaining 15%.[63]

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[62] Ibid.

[63] Ziegler, op. cit.

The U.S. industry began to cooperate extensively with its European counterparts in the late 1940's, initially as licensors, but later also in terms of technological exchange. Of particular importance are the Sikorsky-Westland and the Bell-Agusta relationships.

As early as 1947 a first license agreement was signed with Westland for the S-51 helicopter of which it produced about 130 aircraft as the Westland Dragonfly. Later, in 1950 another license agreement was signed for the S-55 Whirlwind, in 1956 for the Wessex and in 1969 for the S-61 Sea King.[64]

In 1962 Sikorsky entered into an agreement with Sud-Aviation (now part of SNIAS) for a license of the S-68 and a few years later, when Sud decided to go ahead with developing the Super Frelon, a cross license agreement was signed together with an agreement covering technology exchange. In 1965 Sikorsky also signed licensing agreements with Agusta in Italy and several years later with VFW in the FRG for the CH-53.[65]

Bell and Agusta in Italy established an extensive relationship comparable to that between Sikorsky and Westland.

By the late 1970's the Europeans had recaptured a significant share of their own domestic markets, as well as having established a very strong position in world markets, including licensing of European designed helicopters to such developing

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[64] Ibid.
[65] Ibid.

nations as Indonesia, Brazil and Egypt. By 1973 only 15% of the European inventory had been manufactured in the U.S.[66] The Puma-Gazelle-Lynx package has made a substantial contribution to this effort. There were also such single firm successes as the MBB BO-105 and Agusta A-109 observation and liason helicopters; and the SNIAS Lama, Dauphin, Ecureuil (known as Astar in North America), the Super Frelon and the extremely successful Alouette series (the helicopter division of SNIAS is second only to Bell in world helicopter production). These are being further complemented by such new programs as: The SNIAS-MBB-BAC armed anti-tank helicopter; the Agusta A-129 attack helicopter, the ETHEL European tactical transport helicopter, a possible European equivalent to UTTAS, involving potentially SNIAS, MMB, Westland and Agusta; the SNIAS Super Puma; and the MBB-Kawasaki BK 117 utility helicopter.

In July 1978 the process begun with Westland and SNIAS as well as their respective governments, further reinforced by the IEPG and the general momentum toward increased intra-European transnational collaboration, resulted in the Defense Ministries of the UK, the FRG, Italy, and France agreeing on a plan to develop a new generation of military helicopters. The details are being worked out under a steering committee composed of representatives of the chief of staffs of the four countries and the four national helicopter firms concerned i.e., Westland, MBB, Agusta and SNIAS. The agreement under the guise of a "Declaration of Principle" was reached at a meeting of the ministries in the UK. The aim is to define a new helicopter gun-ship, a new tactical transport helicopter and an anti-submarine helicopter.[67]

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[66] Ibid.

[67] Aerospace Daily, July 25, 1978, p. 101.

In summary, the successful Anglo-French 3 helicopter package has furthered the generation of a large bank of European technology and collaborative know-how that will make the next generation of European helicopters even stronger competitors in the world markets, while further reinforcing the divergence of the aerospace industry - government contracting environments on the two sides of the Atlantic.

Also of importance, especially with regards to this Mode, the use of the "family of weapons" approach represented by these three projects will hopefully be expanded to transatlantic collaboration for other weapon system as well. In spite of the unwieldy nature of this approach and with its vulnerability to the unilateral actions of the participants, the "family of weapons" approach is another feasible instrumentality for the improving of NATO RSI, be it on an intra-European basis, or a transatlantic basis.

5. Conclusion

Two previous points are in need of qualification - the greater efficiency resulting from this package deal and that the initial order base was increased. On the first point, although, this arrangement did allow for a relatively rational distribution of work internal to each project at the industry-to-industry level and a one firm-one contracting agency relationship (both being of the same country) one fundamental fact cannot be avoided - there were still two customers. Whatever the measures that can be taken to simplify the contracting relationship, the underlying fact of a multi-customer project remains. Citing Westland's manager director, ". . .the management effort is very large. We deal

with two governments, two treasuries and technology ministries and six services."[68] As for the second point, not unexpectedly, in the case of all three of these projects a somewhat greater vulnerability to the erosion of orders was displayed with regards to those orders made by the nation playing a secondary role. Whether this was due to the particular armed forces having had a less urgent requirement for the system to begin with, especially in a period of drastic defense pruning in both nations, or whether the particular national industry had less of a stake, or some combination of the two, is unknown to the author. The simple observation is that even when a package deal does hold together through development, there is this very discernable vulnerability, in this regard.

Nevertheless, in spite some instability in the otherwise larger order base provided by the two nations' armed forces and the larger management effort involved in dealing with the various components of the two governments, the helicopter package has been a success. Instead of having to totally offset national interests within each project, these interests could be externally offset as well within the overall package, and thus allowing for a more rational distribution within each single project. That is to say, the greater flexibility did definitely allow for an efficient, yet mutually acceptable relationship between the two nations' contractors. In addition to its simple logic, the export results of all three systems can be viewed as substantial indicators of the cost-effectiveness of each project. When the labor government was forced

[68] "New Orders...," op. cit.

into a second drastic cut back in its defense programs in January 1968, the Anglo-French programs were barely disrupted, while the Anglo-American offset program came to an end with the cancellation of orders for the F-111K. Even though the British Army was to take the heaviest manpower cutbacks, the extensive helicopter program was not abandoned, apparently because of the firm commitments with France in joint production. With regards to the general success of the Anglo-French three helicopter program, however, one must keep in mind those problems faced, as well the partial abort of the previous Anglo-French tactical aircraft package, in considering the feasibility of the DoD's "family of weapons concept."

C. THE FAMILY OF WEAPONS CONCEPT

NATO nations have already had experience with the Family of Weapons concept as we've seen with the two Anglo-French package deals - the AFVG fighter/Jaguar and Puma/Gazelle/Lynx packages.[69]

One could possibly also include the three Franco-German missile projects (Hot, Milan, Roland) that have taken place within the framework of a binational missile project effort. But due to the general nature of each system as a 50-50 effort excluding major tradeoff within the package, they were treated under Mode #3. Having yielded design leadership to Breguet for the Jaguar in the otherwise 50-50 joint development and production Jaguar project,[70] BAC was eager to have leadership of the BAC-Dassault team in the TSR-2 replacement, the AFVG fighter, but this second project collapsed two years later in 1967. This in turn led to BAC teaming with the German firm MBB in 1968 for the MRCA. The helicopter package was more successful (as well as the systems being less controversial). Though there were some adjustments in orders, both nations participated to varying degrees in the development and production of all three.

Since 1977 and the assumption of office by the Carter Administration, a recent U.S. variation has been gaining momentum as the "Family of Weapons" concept. This concept was evidently directly inspired by earlier inter-service arrangements worked out among the U.S. Armed Forces back in the 1960's, not the Anglo-

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[69]The first two were principally French and the last principally British.

[70]The Jaguar also took place predominantly within a French contracting framework.

French experience. It also offered the possibility of bridging the gap between the U.S. interdependent approach to R&D and the European joint development approach. And much as this paper distinguishes between three areas of NATO institutional activity and 8 Modes of ad hoc nation-to-nation collaboration within the total Alliance collaborative effort, the DOD views the family of weapons approach as one of three legs of its triad of cooperative actions being initiated within the Alliance. The other two legs of the triad are: bilateral Memoranda of Understanding (MOU's) for the waiving of buy-national restrictions;[71] and dual production in several countries of a system developed unilaterally in one (i.e. Modes #1, #2, #4, #7, and possibly #8).

In early 1979 a U.S. Defense Study Board study group, including representatives of industry and the DOD, completed its study and drafted a report on the development of families of weapons for the North Atlantic Alliance. The group's report concentrates on two areas: air-to-air and anti-tank missiles. It is accompanied by two model MOU's, one for each of the above families, plus it gives an industry point of view on how to consummate the development of weapons families.[72]

One MOU envisions the U.S. as the sponsoring government for an advanced medium-range air-to-air missile (AMRAAM), while either the UK, France or the FRG could be the sponsoring government on the European end, acting on behalf of a multi-national consortium, for the advanced short-range air-to-air missile (ASRAAM).[73]

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[71]The U.S. has already negotiated such umbrella MOU's with Canada, the FRG, the Netherlands, Norway and the UK.

[72]David R. Griffiths, "Weapons Family Concept Backed," Aviation Week & Space Technology, April 9, 1979, p. 14.

[73]Ibid.

The second MOU envisions a division of work with the U.S. having responsibility for the next generation of indirect-fire guided anti-tank weapons, and the European consortium, (again with either of the three principal countries as a sponsor) responsible for the next generation of direct-fire guided anti-tank weapons.[74]

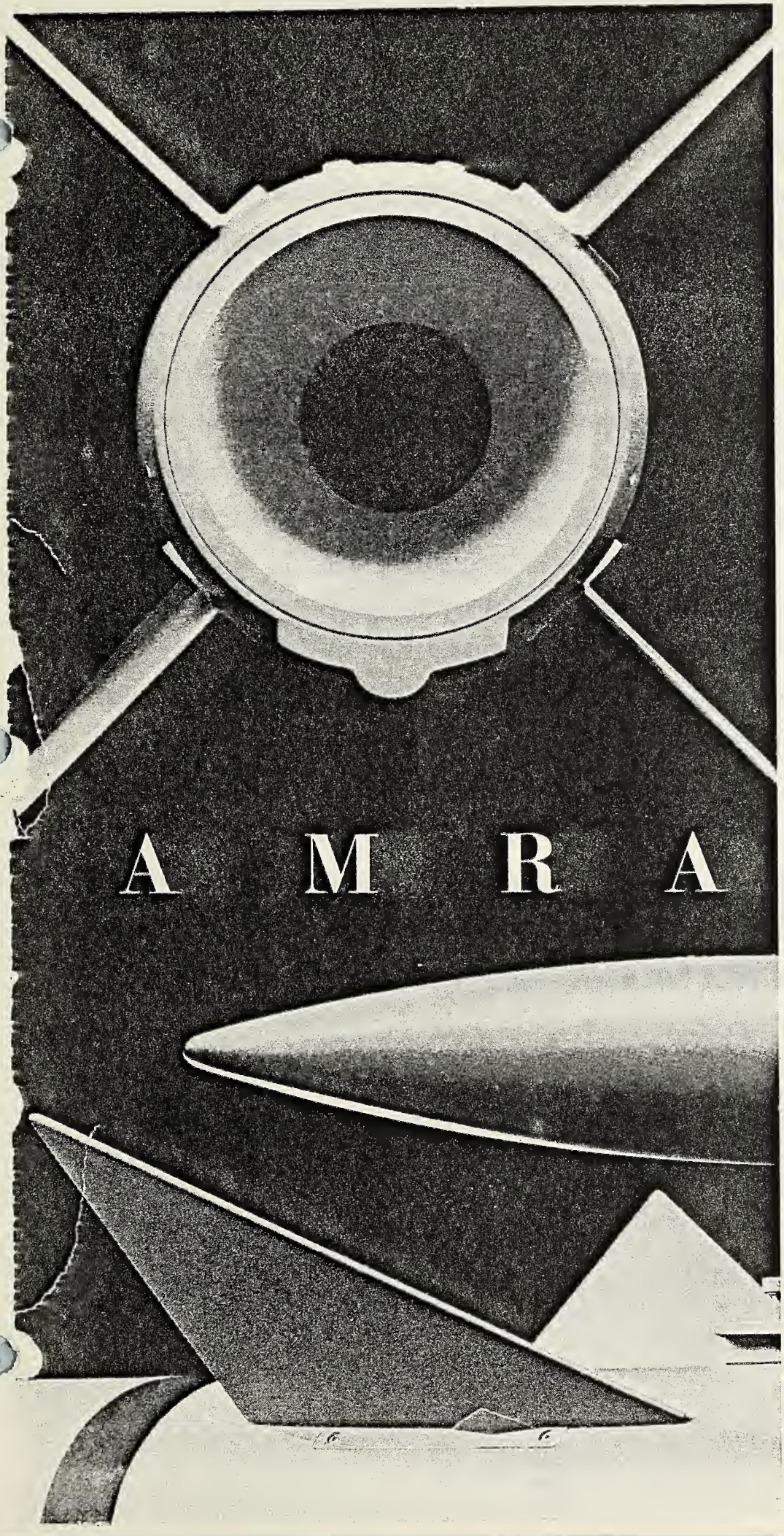
Two designs for AMRAAM from Hughes and Raytheon are presently being evaluated by the USAF to meet future air-to-air missile requirements. This 33-month validation phase of the AMRAAM project will lead to a development and production contract for one of the two companies.[75]

The study group, while calling AMRAAM a good candidate for collaboration, expressed doubts about ASRAAM as a complimentary European effort since it is not yet fully defined and doesn't reflect requirements of all potential users.[76]

The study group, also expressed some reservations as to the logic of the fit of the two designated anti-tank systems, as complementary systems in a single family. As a possible alternative the report mentioned an intensive product improvement effort on current generation anti-tank missiles, such as Euromissile's Hot, while the U.S. concentrates on improvements to the TOW.[77]

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[74] Ibid.
[75] Ibid.
[76] Ibid.
[77] Ibid.



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For work sharing, the model MOU's propose that a minimum threshold of at least 20% of the total subsystem design, development, and testing be conducted by subcontractors on the opposite side of the Atlantic from the prime, as agreed to by the parties involved.[78]

Other facets of the model memoranda include:

- The sponsoring government shall provide 100% of the development program costs by funding its prime contractor according to its own custom. The group said such an approach would be the least complex in terms of defense budgets and financial management;

- Technology transfer directly by industry-to-industry negotiations rather than government-to-government transfer of whole data packages is preferable, partly because such a vehicle will be quicker;

- Family of weapons will be delayed and complicated if the U.S. does not undertake immediately a study to define changes and waivers needed in laws and Defense Department regulations concerning, for example, antitrust limitations, and;.

- Comprehensive source selection criteria must be agreed to at the outset of the program.[79]

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[78] Ibid.
[79] Ibid.

The study group found itself divided evenly on inclusion of European participants in the AMRAAM program. One side said Europeans might view the U.S. as insincere if European subcontractors are not included before 1982, when the engineering development phase is scheduled to begin.[80]

The other point of view held that breaking AMRAAM momentum to allow integration of European subcontractors during the validation phase could "imperil the entire program due to lost time, increased costs, added bureaucratic delays and critical congressional scrutiny."[81]

The study group also singled out the third country sales issue as a major problem area, the current U.S. policy being one of case-by-case determination. The model MOU's stipulated that participants in a family of weapons agreement must meet annually to discuss expanding the sales territory where non-NATO countries are concerned.[82]

Another area where further study was suggested, was the effects that the family of weapons concept would have on the U.S. technological base, i.e., the possible atrophy of U.S. technological capabilities in those areas assigned to European NATO allies.[83]

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[80] Ibid.
[81] Ibid., pp. 14-15.
[82] Ibid., p. 15.
[83] Ibid.

In summing up, the report offered the model MOU's as "policy documents," that may have to be followed up by more specific government-to-government agreements. But, the report qualified this by emphasizing that most of the implementing agreements should be between industries and negotiated by the contractors involved in each program.[84]

William J. Perry, Under Secretary of Defense for Research and Engineering further stated that:

> "On all programs for which we are responsible for development and production, we will select the U.S. prime contractors, subcontractors and European subcontractors on a competitive basis to insure the best technology and lowest cost in the resulting system."[85]

The chairman of the group, R. D. DeLauer, Executive Vice President of TRW, Inc., told Aviation Week & Space Technology, "The report raises as many questions as it answers, such as multiyear funding, source selection, third-country sales and whether technology exchange should be country-to-country. But it will give Bill (Perry) a phase zero to start with. It is something industry can work with, and it's a basis for dialogue with the RSI (rationalization, standardization and interoperability) subcommittee."[86]

Sadly enough, shortly thereafter the House Armed Services NATO subcommittee came out with a report that was critical in its main area of focus: the effort to

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[84] Ibid.
[85] Ibid.
[86] Ibid.

coproduce weapons and make them interoperable. It labeled the two-way street expression, as "an exercise in sloganeering... that has no relevance to sound procurement practices." The committee found no evidence that coproduction will either save money or improve military effectiveness. Also criticized was the Pentagon's "family of weapons" concept. Such a concept, the House committee said, would eliminate competition "and it still remains to be demonstrated that NATO can eliminate competition without lowering technological standards." The committee further found that the U.S. has not honored its commitment to a 3% annual real growth in the Defense budget since President Jimmy Carter agreed to it. Even if the U.S. had honored its commitment, the 3% figure is not sufficient to reverse unfavorable trends in the NATO-Warsaw Pact conventional forces balance, the report said.

Involving a package of two or three related projects, the Family of Weapons concept offers both a more feasible approach than one involving an alliance-wide multi-project division of labor, and a more efficient approach than attempting to obtain all the required intra-group trade-offs within one project. Falling between these two extremes, within a Family of Weapons one can obtain standardization related economics and a more rational distribution of development responsibilities, while also maintaining a politically acceptable set of trade-offs for development and production.

Additionally this concept allows the allies to bridge the gap between the mutually unacceptable U.S. and European developmental concepts. The preferred U.S. approach of interdependent development places a premium on a rational

distribution of work whereby one nation assumes complete developmental responsibilities at both the government and industry levels, followed by second and/or third source production under license in the other participating nations. Due to the dependency involved here, vis-a-vis both fulfilling a given military requirement and its long-term impact on the national technology base, this approach has been politically unacceptable to the 3 European medium powers. The preferred approach for these three has been one of joint development wherein a premium is placed on the nations participating as coequals, a politically more acceptable solution, but one for which the U.S. has found the cost/manageability drawbacks as unacceptable.

Therefore, to take the example of a two project Family of Weapons, on the North American side the U.S. could take the lead in managing one project within the 'Family', with minor work sharing (e.g. 20-30%) being allocated for one or more other participating nations. On the European side, the two or three participating medium powers could assume the lead, with the other European firms, plus North American firms receiving a smaller share of the work. Following development, through license production each system would be produced on both sides of the Atlantic, thus allowing for technology sharing, minimum BOP/employment disruption, standardization and an alternate source while avoiding duplication in the RSD efforts.

In summary, the 'Family of Weapons' concept represents another valid Mode for increasing collaboration, especially on the transatlantic level. Unlike many other schemes it has also proven itself at least to be feasible through its Anglo-French precursors. This Mode offers a mechanism between the extremes of

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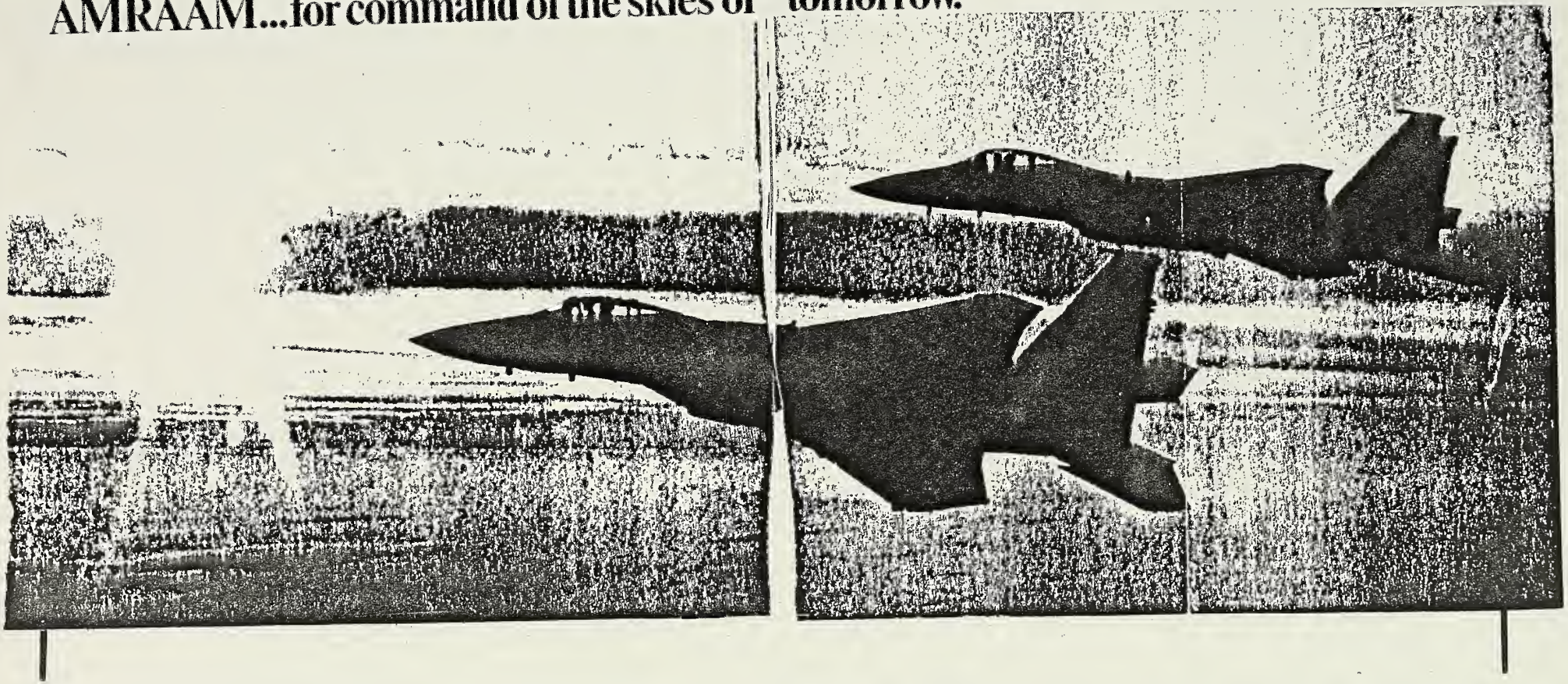
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the alliance-wide approach of the early 50's and 60's and the more prevalent project by project approach. It also combines many of the benefits of the previous seven Modes while avoiding many of their costs. In addition, the 'Family of Weapons' concept can help to bridge the gap between the U.S. and Europe's three medium powers over cooperative development philosophies (i.e., interdependent versus joint).

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